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ABSTRACT

This book is intended to aid educational officials in defining the role of new educational technologies and media and in determining their cost effectiveness. Section 1 contains two methodological studies that examine the application of cost effectiveness studies to new educational media and discuss the use of standard tables for calculating educational costs. Section 2 presents directories of specialized institutions and experts interested in the economics of new educational media. Section 3 includes a bibliography of relevant studies. Section 4 presents abstracts of 18 significant educational cost effectiveness studies. Section 5 contains seven case studies of programs utilizing new educational technologies and media. Section 6 presents glossaries of terms related to new educational methods and economic analysis. (JG)

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The economics of new educational media

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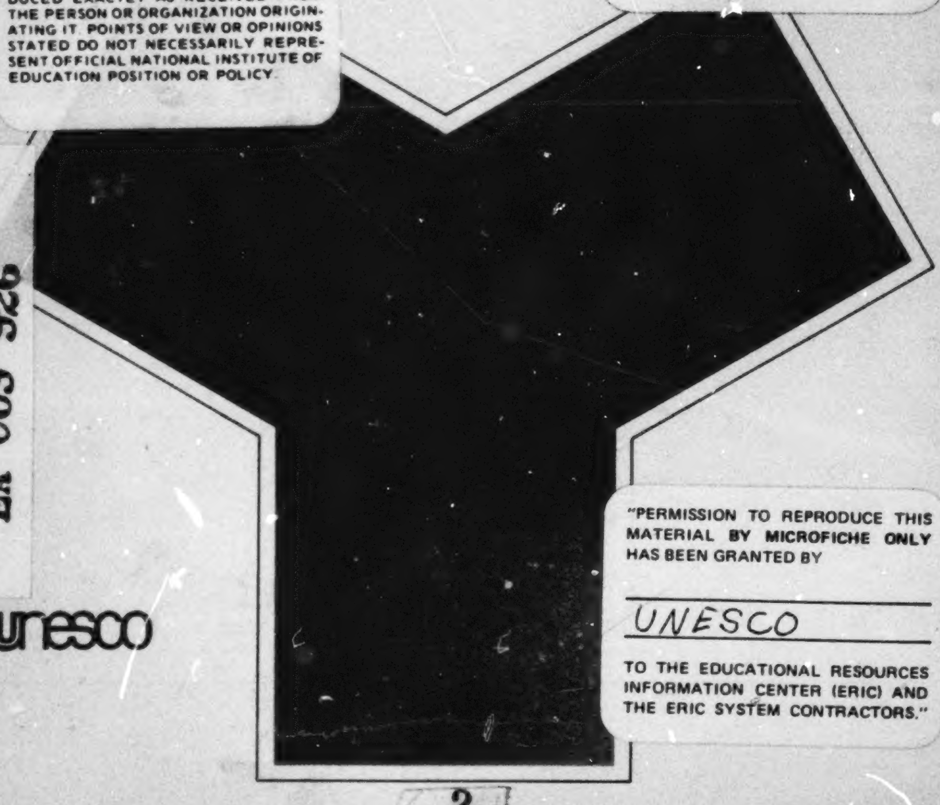

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The economics of new educational media

Present status of research and trends

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Preface

In accordance with the programme approved by the General Conference of Unesco at its seventeenth session, which called upon the Secretariat to assist Member States in defining the role of new educational technologies in education systems and in determining their cost-effectiveness, the Secretariat undertook, as a first step, the task of preparing a complete list of technico-economic and cost-effectiveness studies concerning new educational methods and media, with a view to drawing up a descriptive inventory and to defining methods and principles which would facilitate international comparison of the studies in question and promote a dialogue between research workers, decision-makers and educators.

For this purpose, the International Council for Educational Media (ICEM) invited Unesco National Commissions, public and private bodies in Unesco Member States and research workers in this field to inform it accordingly by sending in a list of their work, accompanied by a summary and, if possible, the full text of their studies.

The investigation and identification of studies proved to be an extremely difficult task: few studies are published; others, in spite of their titles, are only vaguely related to the problems of cost analysis; the research workers themselves are isolated and scattered throughout many different institutions. In spite of these difficulties, more than 200 studies from OECD, Unesco and IIEP, France, the Federal Republic of Germany, the Union of Soviet Socialist Republics, the United Kingdom and the United States of America have been catalogued and abstracts made of the most interesting.

It became obvious that the results which could be drawn from these studies were frequently contradictory, that the various research workers had adopted working hypotheses that it was difficult to harmonize *a posteriori*, and that even the concepts used for cost analysis were not compatible.

In January 1975 the studies were submitted to a group of international experts, which recommended that the list should be published and that the task of identifying common criteria and contributing to the adoption of comparable procedures should be continued.

Following this meeting, Unesco issued a provisional document containing an introductory report, a summary of the discussions and a list of recommendations. Annexed to the document were a bibliography of cost studies relating to the media and a provisional list of specialized institutions and research workers.

On 18 and 19 June 1975, at the request of Unesco, ICEM convened a small working group to attempt to find ways of applying the recommendations of the previous meeting with regard to the establishment of models of standard tables for presenting the various types of costs and the development of a grid indicating the hypotheses, framework and methology adopted for the case studies.

The report of the working group, together with the provisional document mentioned above, was sent to the institutions and experts who had taken part in the first survey to enable them to make comments and amplify the annexes.

The present publication describes the current state of this work.

In its present form, the inventory lays no claim to exhaustiveness. It may, however, be regarded as the first issue of a periodical publication, depending on how cost-effectiveness studies develop.

The Secretariat intends to continue its activities designed to assist in setting up an international network for the pooling and exchange of information on the development of the technico-economic aspects of educational methods and techniques, as they are actually introduced into educational practice.

For this purpose, the Secretariat invites specialized research workers and institutions to draw its attention to any omissions and to work in progress, with a view to producing an updated version of the inventory in 1978. All correspondence should be addressed to the Division of Methods, Materials and Techniques, Education Sector, Unesco, Place de Fontenoy, 75700 Paris.

The views and opinions expressed in the studies reproduced in this work are, of course, those of the authors and not of Unesco.

Acknowledgements

The Secretariat of Unesco wishes to express its gratitude to Mr Dean Jamison, who kindly authorized the reproduction of four case studies of educational radio and television published in *Cost Analysis for Educational Planning and Evaluation: Methodology and Application to Instructional Technology* by Dean T. Jamison, Steven J. Klees and Stuart J. Wells (Princeton, N.J., Economics and Educational Planning Group, Educational Testing Service, 1976), and to Mr Walter Wiegel, who authorized the reproduction of a communication on the costs of a resources centre presented by him to the ICEM conference held in Glasgow in October 1975.

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Methodological studies

Cost-effectiveness studies applied to the use of new educational media

Methodological and critical introduction

J. C. Eicher

The educators' world is often a closed and conservative one. It is marked by a general apprehension of technology, which is readily accused of being 'dehumanizing'.

More lucid minds, however, have very quickly seen what upheavals might be brought about in traditional teaching methods by introducing the revolutionary innovations of recent decades in the field of information media.

Some have even gone as far as to consider that since, in our radically changing societies, the educational system itself must be overhauled from top to bottom, there was cause for satisfaction in the fact that 'the need for such changes in education arises at a time when media of communication—radio, television and the film—and new methods and techniques of instruction, such as programmed learning, have come on the scene'.[1]

But in fact, innovations in teaching methods have so far almost always remained marginal, and moreover have generally been introduced without such forethought as would have enabled their advantages to be identified and compared with the expenditure involved. Nevertheless, experiments have multiplied, together with attempts at evaluation; some interest is beginning to attach to a stock-taking of the situation, for many methodological problems have now been solved or are about to be solved, and many others can at least be defined in more precise fashion.

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[1] R. Maheu, 'Foreword' in: W. Schramm *et al.*, *The New Media: Memo to Educational Planners*, Paris, Unesco: IIEP, 1967.

The many problems which educational systems must face owing to the development of modern techniques of recording and remote transmission of information are, in fact, all more or less directly linked with the need to compare their cost and their effectiveness. Local and national decision-makers should therefore be helped to view the problems clearly, particularly where local resources are very limited and there is a need to gear the educational apparatus to the urgent requirements of a developing society. Unesco has accordingly taken the initiative of instigating a measure of collective thinking which should lead to the harmonization of methods of calculation and of approaches to the problem of introducing modern technologies into education.

It is not the purpose of this introductory document to propose a single obligatory method: the author feels quite unqualified to do so and in any event would regard such a proposal as premature. He will not even attempt to draw up an exhaustive table of research already carried out, classified under precise headings; this would probably prove tedious and perhaps not particularly useful. His aim will be more modest but, he trusts, more realistic, namely to identify the areas in which studies already seem to reveal undoubted comparability, those in which method is not yet strict or homogeneous, and those, lastly, where it appears neither possible nor desirable to adopt a pre-established, standardized pattern. Many of the problems involved are obviously common to all cost-effectiveness analyses. We shall attempt, on an analytical basis, to consider successively those problems involved in measurement of cost and those which arise when it is desired to evaluate the effectiveness of an innovation. But before doing so we shall start with an observation that cannot fail to be made after a perusal of the very many studies already carried out, namely the remarkable variety of frameworks of analysis selected; and we shall attempt to determine which types of research should be developed and which appear to be of little use as an aid to decision-making.

General problems concerning the framework of analysis

A scrutiny of the studies carried out shows that there are at least four different directions in which the framework of analysis selected is extensive in varying degrees. These apparent inconsistencies can in fact be explained by reference to the objective pursued, which can be established at three different levels.

Apparent inconsistencies noted

The characteristic features of the modern means of recording and of remote transmission of information are their reliance on advanced technology and their variety. They can thus be assessed in several ways:

1. Certain studies elect to examine them from the point of view of one of the partners in the decision bringing about their adoption.

   There are three partners: the technician, the economist and the educator. In our view, studies which take only the standpoint of one or even two of these partners cannot provide much assistance to the decision-maker and should, therefore, be discouraged.

2. Certain studies consider only one of the technical media and explore the problems of its isolated use from the cost-effectiveness aspect.

   Some of these studies are extremely limited in scope: they confine themselves to describing one specific experiment and to measuring its cost and results. Others attempt to pose the problem in more general and abstract terms by establishing, for example, a cost-variation law in accordance with the size of the operation (e.g. defined by the number of pupils involved). But studies reflecting a greater degree of synthesis all demonstrate that no solution based on a single technical process is entirely satisfactory and that we must calculate in terms of a combination of media.

   Our conclusion here, therefore, is the same as in the preceding case: estimated-cost studies covering the use of a single technical medium do not lend themselves to generalization ('optimization'). They should for that reason be discouraged. As for case studies, these cannot generally be extrapolated and their interest is thus very limited.

3. Certain studies choose to examine the purely marginal use of modern media, whereas others propose the reorganization or even the total remodelling of the educational system through the use of these techniques.

   In the first case, the basis is a given structure which is not called into question. All that is asked is whether what is being done (education in its traditional forms) can be done slightly better by using certain 'tools' likely to assist the teacher. In the second case, the modern media form the starting-point for the construction of a novel educational system.

   Studies of each of these two forms of utilization are obviously not comparable, but neither can be rejected *a priori*. Studies of the first type have three features which limit their scope:

(a) From the point of view of cost: what is proposed is an addition to an existing system. The cost of the new structure is necessarily higher than that of the old.
(b) The whole potential of the new instrument—which is introduced only as a minor complement—cannot be exploited. There is a risk, in particular, that costs per pupil will be high, since the considerable economics of scale made possible by the mass use of the media cannot be achieved.
(c) From the point of view of efficiency: there is a marginal improvement in the efficiency of a given system, in a way that cannot always be measured, whereas we know that much more substantial improvements would be possible through a change of system.

These studies should, however, be continued, since there must be a constant striving towards improving the quality of the service provided, and since only systematic comparison of the relative costs of the various technical solutions adopted will make it possible to eliminate the wastage observed at present (under-use of costly instruments—or failure to use them at all—because their function has not been thought out in terms of the time situation at the outset, because the teacher has not learned how to use them, because operating costs have not been evaluated in advance and prove to be prohibitive, etc.).

Studies of the second type, on the other hand, are much more ambitious but also much more dangerous. They propose, in fact, to replace the existing educational organization by another.

We do not intend here to pass judgement on these studies, but two comments appear to be called for.

First of all, these studies must on no account be systematically discouraged. The profound upheavals to which our societies are being subjected (in the East as in the West, in the industrial nations as in the countries striving to achieve development) are sufficiently obvious for us to conclude that educational systems are themselves fated to change. This being the case, it is obviously better for such a transformation to be thought out coherently rather than to be imposed and anarchical.

In the second place, these studies should not be conducted no matter how and no matter by whom. The educational system performs too important a role in society for its reform to be embarked upon without our having reached a consensus regarding objectives. Here, if only indirectly, we come once more across a danger referred to above, namely that of studies that reflect the preferences of only one of the partners involved. For what must be avoided are reform proposals that are merely a cover for a manufacturer's desire to open up a market, or the Utopia of an educator who fails to give due weight to social and political considerations, or again the bleak, narrow analysis of an economist who, in his calculations, confuses the notion of effectiveness with that of profit.

4. Lastly, certain studies start with the educational system considered in its specificity, whereas others simply look at the problem of the optimum use of modern techniques for recording, storing and disseminating information.

The problem here closely resembles the preceding one, without, however, merging with it.

The complex character of the media viewed from a technical standpoint makes it in any case necessary to study the problem of the organization and optimum association of the technical media in relation to the volume of information and the size and dispersion of the audience for which it is intended. These studies, which regard the educational message merely as one among others, are therefore indispensable at the outset.

We would, however, suggest that attention should be concentrated henceforward on studies which start from the basis of education regarded as a specific system, and this for two reasons:

(a) The problem of the optimum use of the media according to the message and the audience is now, in our view, thoroughly mastered.

(b) As stated above, the essential problem (which has not been mastered) is in fact the organization of an educational system geared to contemporary society and to its state of flux. It is thus logical to take the specific objective as the starting-point in order to arrive at the optimum use of the media, whereas it is often dangerous to consider the media as a basic element and to try and adjust the objectives accordingly.

In brief, we can say that among the very many existing studies, only the following are of interest as an aid to decision-making: (a) those that consider the points of view of the three partners at one and the same time—technician, economist, educator; (b) those that consider several competing media simultaneously; (c) those that take the educational system as their point of departure.

For purposes of valid comparison, these studies must be grouped according to the objective in view.

The necessary regrouping

We must state here an obvious fact which tends to be overlooked: 'optimization' is the adaptation of limited means to the objective being pursued in such a manner as to achieve a given result with the minimum resources (at the lowest possible 'cost') or to obtain the most effective result (maximize the 'benefit') for a given outlay of means.

Everything depends, obviously, on the objective chosen and on the available means.

In the case which concerns us, three types of possible objectives can be identified, the first two of which are marginal (although in very different ways) and the third all-embracing and 'revolutionary'.

Objective No. 1: Marginal improvement of the reception of a given message by the introduction of modern techniques. The point of departure is the existing system and the proposal is to make the 'teacher's' work more effective and to put more life into his relations with the class, although he remains the basic instrument for the transmission of knowledge. This has been, so far, the objective in the majority of the experiments studied.

There may be two parts to this objective: in the first, the teacher uses modern methods for all or part of his teaching; in the second, certain parts of the teaching experience or programme are dealt with using machines.

We have already noted the criticism that can be levelled at such an objective, which necessarily means that only a small proportion of the potential of modern media is used. The studies carried out, however, reveal interesting facts. We shall review in the following section the conclusions that can already be drawn with regard to comparisons of costs and efficiency in these marginal experiments.

Objective No. 2: The extension of educational services to groups which the traditional system has not reached. This objective also leaves the structure of the 'traditional' system intact, but it is more ambitious than the preceding one in that it proposes to develop an original educational system for fringe groups.

The groups most frequently catered for by the projects so far studied are: (a) illiterate adults; (b) rural adults (so to as induce them to adopt appropriate behaviour patterns for development purposes); (c) children in remote zones with a scattered population; (d) working adults who have no free time to attend classes in traditional establishments.

The complexity of 'optimization' problems increases here. Comparison is made difficult by the fact that only one fraction (which varies in every case) of the target group is actually involved in each of the experiments studied. Transposition to the educational system as a whole is impossible.

Objective No. 3: Reform of the educational system through the introduction of modern techniques on a mass scale. We know that the introduction of modern techniques on a massive scale makes it necessary in any event to take a fresh look at educational aims and methods and to reformulate them.

Problems here are much more complex, including, at the technical level, the creation of new networks for the transmission of the 'messages'.

At the level of the educational system we come up against a considerable constraint: the existence of previous structures (in particular the presence of teachers whose work is governed by a variety of strictly defined regulations); the new objectives must be defined before attempting the 'optimization' process.

Studies of developing trends are indispensable, but there is a risk that they cannot be compared between one country and another because of the sharp impact of the aims selected upon the costs of the different methods.

Case studies, not surprisingly, are still few and far between and give widely differing results. However, an idea of orders of magnitude can be gained.

It is accordingly vital to regroup studies according to the objective in view before making comparisons. When this has been done, comparisons cease to be impossible or absurd; they become merely intricate.

We shall attempt to demonstrate this by considering first of all costs, and then effectiveness.

Problems linked with cost measurement

It seems useful at this point to remind ourselves of the main problems involved in seeking to make an accurate measurement of the cost of introducing modern educational media. A recapitulation of the observations found in various studies will enable us to suggest certain points of difference and certain methods. This done, it will be useful to sum up the comparative results of the different measurement attempts made so far.

Categories of costs and their measurement

Four types of classification of a complementary nature seem necessary if we are to obtain a complete picture and if the categories are to be sufficiently detailed to allow comparisons: (a) a *technical* classification in which costs are categorized according to the various technical operations that have to be carried out for information (an educational 'message') to be received by the person or persons for whom it is intended; (b) an *economic* classification that distinguishes between fixed and variable costs; (c) an *accountancy* classification that distinguishes between capital costs and operational expenditure; (d) a *financial* classification by contributor, whereby direct and indirect costs can be distinguished.

Technical classification of costs

To send a message to its recipient by an indirect channel (i.e. other than through the teacher's lips) we must in turn: (a) decide on the message to be transmitted; (b) develop the most appropriate technical device for recording this message; (c) ensure transmission and distribution of the recorded message; and (d) develop the most appropriate method of reception.

The first operation does not appear to concern us as no technical process is involved. In fact, however, due regard must be given to the available technical media, for while it would be incorrect and illogical to start with techniques and adapt the message to them, it would be equally wrong not to take technical constraints into account. The risk is that these constraints may be such that a large part of any message formulated in the abstract might be lost before reaching its audience.

Three remarks may be made concerning this classification.

First, it raises problems of nomenclature, since certain costs are difficult to classify in one of the four categories, namely formulation of the message, production, transmission or distribution, and reception. For example, in which category should we place expenditure on the duplication of the recorded messages (films, tapes, etc.)? We could consider classifying them under production (for as many copies of the recorded message as will be required must be produced), under distribution or under reception. There is also the cost of rental or installation of cables for closed-circuit television, or the cost of maintaining liaison with the 'pupils'. But these are, we believe, more often than not questions of common sense: all that is required is for the person carrying out the study to define and justify his choice.

Second, this classification is very useful, because the relative cost of each stage in the process varies considerably according to the technical medium used. Thus transmission costs are generally higher, in terms of production cost, for television than for radio.

Third, this classification is insufficient in isolation, for it provides no means of establishing whether particular costs fall under expenses of initial establishment or under current expenditure on a system in operation.

Economic classification of costs

This classification distinguishes costs according as to whether they are variable or invariable, having regard to the dimension of the operation.

Within each of the technical classification categories, it will thus be possible to distinguish between constant and variable costs. For instance, fixed costs at the reception stage include the purchase or rental of equipment (radio or television receivers, film projectors and screens, loudspeakers, etc.) and certain upkeep costs (salaries of maintenance staff, for example). Variable costs include the purchase of tapes, recording heads, projector lamps, etc., the cost of which in a given period varies with the number of hours of instruction, salaries of those responsible for liaison between equipment and 'pupils' (supervisory staff, technicians) and so on.

It will be seen that certain invariable costs are fixed costs, i.e. they are incurred once and for all, or at least at considerable intervals (projection apparatus, for example), whereas others are recurring, i.e. they are repeated from period to period (maintenance staff salaries). This distinction is useful when we wish to study a system in course of establishment, as provision must be made both for the initial financing and the amortization that will enable the capital to be preserved intact. We will revert to this point under budgetary classification.

Before going on, however, four remarks are called [illegible] concerning calculation of economic costs:

1. Certain authors include in their costs both the purchase price of equipment and an annual amortization in respect of such equipment. There is a danger here of including items twice, to the extent that the cost of repairs and maintenance, as well as the purchase of new equipment, are both reckoned.
2. Some authors add an interest charge to amortization. From the wider economic standpoint, this is correct, since we are dealing with scarce resources that would have brought in a return if loaned (or invested elsewhere). But since all we are doing is to compare the relative cost and effectiveness of different educational methods this addition is not necessary, and its omission obviates the need to make a choice—always arbitrary—of interest rate.
3. The amortization calculation should be based, in theory, on the obsolescence and technical wear of equipment, but in practice it is sometimes better to opt for a 'financial' amortization which takes into account the evolution of sources of finance and of currency resources where certain equipment has to be purchased abroad.
4. Not only total costs, but also unit costs should be calculated. The two most useful categories of unit costs are cost per hour of contact and cost per student. They can be brought together to form a combined index: cost per student-hour.

   Some of these unit costs may prove invariable, where the corresponding total cost varies in proportion to the reference variable (number of hours, number of students or number of student-hours).

The accountancy or budgetary classification

This classification distinguishes between two categories of expenses: capital (or investment) expenditure corresponding to the financial effort made to constitute assets, and operating expenditure. This distinction can be useful, inasmuch as it allows comparison of the cost of the initiatory stage, and the current operational costs of an established system. The figures needed for this classification are, furthermore, often those most easily available. However, it is neither essential nor wholly satisfactory, since: (a) it contributes nothing further than the economic classification, in so far as the latter can be obtained in its entirety; (b) it is useless once the initial investment has been made, as only operating expenditures are subsequently involved; (c) it is not normal budgetary practice, in the case of public funds, to include amortization charges in the operating expenditure budget.

Financial classification by contributor
This classification distinguishes between costs which are to be met by the organization responsible for capital investment, costs to be met by users, and costs falling to the community.

This distinction can be particularly useful in instances where the proportion to be met by the two last payers is substantial. Its importance is heightened by the fact that the evaluations made in the studies reviewed often tend to underestimate or to overlook these categories completely. Let us take the examples of a project involving the part-time use of an existing television channel. The direct cost of the operation—the only one generally reckoned—does not include use of this channel because it appears to be provided free of charge. Nevertheless, the costs of setting up transmitters and relay installations were incurred at the outset with a view to the full-time use of the channel; logic would then require that this investment should be charged to the educational system in proportion to the hours used. Failure to reckon this indirect cost is tantamount

TABLE 1. Classification of costs

Technical costs	Economic costs	Financial cost (by contributor)
Conception	Fixed Invariable Variable	Educational authority Community Family Others
Production	Fixed Invariable Variable	Educational authority Community Family Others
Transmission and distribution	Fixed Invariable Variable	Educational authority Community Family Others
Reception	Fixed Invariable Variable	Educational authority Community Family Others
TOTAL	TOTAL	TOTAL

to self-delusion concerning the real cost of such an operation, since it amounts to believing that there will always be transmitters ready-installed and providing a channel with available hours that can be 'appropriated' free of expense.

Similarly, if part of the cost is met by the student (the purchase of a television receiver, for example, in the case of tele-education), failure to include it amounts to shifting, in an insidious fashion, the burden of the educational system from the public authorities to the individual.

To sum up, the classification in Table 1 may be suggested as one which provides an exhaustive and 'realistic' picture of costs.

These costs can be calculated per student, per hour or per student-hour, according to need. Some of the spaces can obviously remain empty. We can now review what we already know concerning costs and their variations.

Results achieved

Results are of two kinds:

We begin first by obtaining a fairly accurate idea of the main cost trends in relation to the magnitude of the system involved.

Next, certain differences in the results, if interpreted correctly, indicate thresholds and behaviour patterns of prices.

Cost variation laws

Let us first consider total cost, before studying its components.

Total cost. The easiest index to interpret is that of cost per student-hour. The various evaluations bearing on extensions of a single system, or on systems of differing dimensions, lead, it would seem, to the following observations:

1. Evaluation of cost per student-hour in terms of the audience served differs considerably according to the technical medium employed:
    (a) The media giving the greatest economies of scale are television via satellite, open-circuit television, closed-circuit television and radio.
    (b) The media whose use gives the least or no economies of scale are language laboratories, computer-based teaching and films.
    (c) The media for which unit cost increases with the magnitude of the project are films (once a certain level of population dispersion is reached) and video systems, the cost of which quickly becomes prohibitive because of duplication problems.
2. The choice of the technical medium obviously depends in part on the geographical area to be covered and on the audience.

Television is thus always too costly when catering for no more than a small number of pupils. But its cost per student-hour drops very quickly up to a figure of 1 million students; thereafter the rate of decrease is much more moderate. The threshold is even higher for television via satellite, which can only be considered for the coverage of a vast area.

As a general rule, the 'little media', i.e. those requiring relatively simple, inexpensive equipment (slide projectors, epidiascopes, tape recorders, radio, etc.), offer far greater advantages than the 'big media' (television, computer-based instruction) for small audiences, the relative advantage diminishing subsequently. On the other hand, beyond a certain size of audience, the 'little media' cease to be of any interest, with the exception of radio which keeps a relative advantage whatever the audience size.

Specific costs. Two types of comparison can be made:

1. Comparison based on the technical classification:
   (a) Production cost is particularly high, whatever the size of the system, for film; it is relatively high for television, but drops very rapidly from an audience-level of approximately 2,000 up to 200,000; it is low in the case of radio and does not drop noticeably with the size of the project.
   (b) Transmission and distribution cost is very high for video systems; it is high below 200,000 students but drops rapidly and then rises slightly from 1 million students upwards; in respect of open-circuit television it is moderate and stable for films; and for radio is moderate below 100,000 students and very low above.
   (c) Reception cost is high, dropping only slightly in relation to the size of the system, for film and television; and is moderate with a noticeable reduction between 15,000 and 150,000 students for radio.
2. Comparisons based on the economic classification. It is now possible to compare, on the one hand, the fixed costs or initial installation expenditure and, on the other, the variable or operational costs:
   (a) Fixed costs are much higher for television than for radio (of the order of 10 : 1). They vary considerably with the geographical coverage and the number of broadcasting hours (ranges of 1 : 12 for radio, 1 : 100 for television). Everything depends here on the possibility of using existing installations.
   (b) Variable costs drop very quickly with the size of the system (in the case of television they may fall from $5–$10 to 5–15 cents; for radio, from $1 to 1 cent). They are always much higher for television than for radio.

These criteria are extremely valuable in themselves as decision-making aids. It is possible, in particular, to determine which media it is or is not reasonable to use under certain conditions.[1] It should also be stated, however, that the differences in results between one study and another are still considerable.

Discrepancies in results and certain possible explanations

Certain variations of evaluation remain to a large extent inexplicable and lend support to the need for precise nomenclature and uniform evaluation methods. The outstanding example relates to the different evaluations of the cost of educational programmes televised via satellite in Africa.

However, this is not always the case, and certain discrepancies are, on the contrary, extremely instructive.

The most frequent case is that of evaluations made at different times. They generally show, for the same medium, a drop in unit costs. This is particularly true in the case of computer-assisted instruction where the unit cost has dropped by three-quarters in about five years.

These remarks show that we must be wary of concluding, once and for all, that it is advantageous, or on the contrary too costly, to replace traditional teaching by 'modern' methods.

Variations in cost between different contemporary experiments reveal, on analysis, the determining influence of the following factors: (a) the possibility, to a varying extent, of using existing infrastructures; (b) specific features of the area to be covered (physical features, area for a given population, etc.); (c) specific features of the population to be reached (homogeneous group or otherwise, in employment or not, etc.).

Despite the wide discrepancy in evaluations, we can therefore claim that the results already achieved provide us with a certain degree of knowledge of cost-determining factors; this knowledge can serve as a basis for approximate but reasonable evaluations where not all the figures are available. As far as effectiveness is concerned the situation is less satisfactory.

Problems connected with measurement of effectiveness

Effectiveness is infinitely more difficult to assess than cost. It has, in fact, several dimensions, some of which are hardly capable of being measured.

Measurement problems depend to a very large extent on the definition adopted.

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[1] An Agency for International Development study may be consulted on this subject: W. Schramm *et al.*, *Big Media, Little Media*, table 16, p. 104, Stanford University, Institute for Communications Research, March 1973. (AID Studies in Educational Technology.)

In spite of these difficulties, certain lessons can be learned from the evaluations that have already been made.

Problems in the choice of a definition

These problems exist at three levels: (a) we must first of all distinguish between educational effectiveness and economic efficiency; (b) if we elect to measure educational effectiveness, this can be defined in relation to the aims of traditional education or to those assigned to the new system using modern educational media; (c) we have, lastly, to distinguish between effectiveness in theory and effectiveness in practice.

Economic efficiency and educational effectiveness

Economists frequently confuse 'profit-earning capacity' with effectiveness. In the case of the educational system there are two very cogent reasons for not making shift with a cost-benefit analysis which mixes these two concepts.

First of all, the viability of the study process is linked with the additional benefits that educated individuals can command in comparison with those who have not continued their studies. But here we are dealing with the viability of the individual; and recent inquiries have shown that the fact that these differences in gain can be explained in great part by something other than the extra knowledge assimilated emerges sufficiently clearly to justify us in querying the value of the hypothesis that establishes a strict causality between the level of knowledge and that of benefit. Furthermore, collective profit-earning capacity is not necessarily equal to the sum of the earnings of the educated individuals.

In the second place, educational aims are much more varied and ambitious than mere economic viability. It is then logical to define the effectiveness of the system according to its own aims rather than in relation to objectives which lie outside it. This is in our view the true conception of educational effectiveness.

It must, however, be defined in more specific terms.

Effectiveness in relation to the objectives of the traditional system or to new objectives?

If the purpose is to make minor improvements in the traditional system, effectiveness must, of course, be evaluated in terms of the objectives of that system.

Two complementary indices are generally used: (a) the time required for the average pupil to attain the level of knowledge considered normal on completion of a given course; and (b) the percentage of pupils attaining a given level of knowledge.

It is thus possible to ascertain whether the innovation has been 'effective', i.e. whether it has enabled the objectives of the system to be achieved more fully.

But in so far as the introduction of the modern media is on a mass scale, in regard either to groups previously outside the system or to the total school attendance, the old system is disrupted. It would then be incorrect to judge the performance of the new structure on the basis of the objectives of the old, for modern techniques can have the advantage, among others, of aiming at new objectives that are more in keeping with recent educational discoveries and with the demands of contemporary society.

In this case the new objectives are the point of departure for the definition of indices of effectiveness. We might, for example, want to obtain an index of creativity or of individual initiative.

Effectiveness in theory and practice

Theoretical effectiveness is that which corresponds to the optimal use of modern techniques.

Two phenomena may, however, keep real effectiveness below this theoretical level:

First, evaluation of effectiveness is not always carried out at the time of the instrument's technical development, but only when it comes to be applied. This fact, observed in almost all the cases studied, leads us to wonder whether the effectiveness then observed is not very much below what it might have been if the optimal combination of technical media had been developed in relation to the aims pursued.

The problem is thus the following: we do indeed measure practical effectiveness, but we do not know whether this effectiveness comes close to the maximum effectiveness of modern media used to best advantage. We must therefore urge in the strongest terms that evaluation should be carried out at the technical-development stage of the media.

Second, effectiveness assessed by means of a control audience may not be achieved in practice because of a negative attitude on the part of the educational group at hand. For example, television can increase the effectiveness of the teacher by freeing him from certain mechanical tasks, on condition that he accepts the instrument and does not feel that he has thereby been deprived of some of his prerogatives.

We must, therefore, not delude ourselves as to the effectiveness of these new methods by disregarding the obstacles; we must, on the contrary, try to assess such obstacles before we can combat them.

Lessons to be learned from evaluations already made

All serious cost-effectiveness studies include an evaluation of progress in the results achieved by means of the new methods. In spite of difficulties of comparison, due more especially to the lack of homogeneity in definitions, it would appear that the following postulates can be put forward:

1. In the developed countries, the pace of the learning process and the percentage of pupils reaching a given level of excellence seem to be roughly the same whatever type of structure is selected.

   In particular, no superiority of the 'big media' over the 'little media' can be detected, nor any over-all superiority of modern methods over traditional teaching.

   On the other hand, a number of pilot projects carried out in the developing countries seem to indicate the greater effectiveness of modern methods, particularly in the case of the least-gifted pupils.
2. There is no indication that certain technical media are generally better than others from the point of view of their effectiveness. It cannot even be proved that a combination of media is always more effective than the use of a single technique, since most of the experiments are, to varying degrees, multi-media.
3. It seems, on the other hand, that most media can properly serve as adjuncts to the majority of teaching activities.
4. Lastly, there does not seem to be any significant difference in the effectiveness of a method according to individuals. The most gifted succeed better, in general, whatever the method.

The conclusion is, then, that modern educational techniques do not seem to be any more effective than traditional methods if effectiveness is defined on the basis of the traditional objectives.

If another definition is taken, this comparison becomes impossible. We can do no more than compare one modern method with another.

This conclusion leads to another: under present circumstances, the choice between different methods has to be made following comparisons of cost alone. There is here an additional reason for stressing the need for homogeneous methods of calculation covering clearly defined, universal categories of cost.

Standard tables for cost measurement

F. Orivel

Following the recommendations of the meeting on information exchange on technical and economic aspects of educational technology held in Paris on 14–16 January 1975 (*Final Report*, Unesco doc. ED/75/WS/34) a small ad hoc working group of experts met in Paris on 18 and 19 June 1975 in order to: (a) prepare standard tables for cost measurement in media systems thus enabling a precise study to be made of cost variations; (b) define cost units to be used in such studies; (c) prepare a matrix for identification of media systems (precising hypotheses, framework and environment) enabling standardization or harmonization of all information needed for cost studies.

Standard tables for cost measurement in media systems

Principles of a classification table for costs

A choice of three proposed tables was open to the group for the definition of a classification of cost of media, or those educational systems relying on media:

1. That contained in the report by Professor Eicher referred to above (see Table 1).
2. That contained in the Unesco/ILO International Survey on cost of programmed instruction. This is based on a breakdown of technical costs by technical functions:
   A. Pre-production cost.
   B. Design and production costs.
   C. Promotion cost.
   D. Reproduction cost.
   E. Distribution cost.
   F. Implementation cost.
   For each of which a breakdown is made by types of cost:
   I. Cost of men, means and materials.
   II. Equipment (heavy and light).
   III. Building cost.
   IV. Overhead costs.
3. That proposed by Mr Oatey in measurement of media cost. Mr Oatey proposed for decision-making purposes a classification of costs by behaviour, that is, according to the way they vary with different levels, inputs, outputs or other measures of volume or activity depending on the volume of the systems.

   This implies a unit in which the size of a system can be measured. Mr Oatey proposes to use the following volume bases for computing media cost in case studies: number of course units, number of duplicates per course unit, number of presentations per course unit, but the definition proposed is unfortunately not standardized from one medium to another or from one media system to another:

Master costs	Fixed, Variable	with respect to course unit
Duplicate costs	Fixed, Variable	with respect to course unit
Presentation costs	Fixed, Variable	with respect to course unit

Professor Eicher's classification is a classification by function, but sharing facilities between functions, often on the basis of arbitrary allocations. According to Mr Oatey, classification by behaviour involves the separation of fixed and variable components and provides an approximation to marginal cost required for decision-making; there are no problems of arbitrary allocation. Classification by function involves the allocation of fixed cost to volume units, producing an average cost which is more difficult to interpret.

Mr Steuer reported on the difficulties encountered in applying the matrices prepared for the international survey on the cost of programmed instruction which he found too detailed for practical use.

Comparison between Eicher's and Oatey's classification

The group agreed that correlation between Eicher's and Oatey's classification was possible: (a) the master costs, which correspond—in Professor Eicher's classification—to conception and production costs; (b) duplicate costs, which are the equivalent of distribution costs in the Eicher grid; (c) presentation costs, which correspond to operational costs.

Fixed, invariable and variable costs

Each of these three types of cost comprises a fixed cost (which does not change with the number of units produced) and a variable cost (which does change with the number of units produced).

There was a long discussion on this distinction. Two points were tackled: the transition from this terminology comprising two elements to that of Professor Eicher which comprises fixed, invariable and variable; and the content of fixed costs.

On the first point, Mr Orivel stated that the transition from one terminology to the other was quite simple from the theoretical point of view. Mr Oatey's fixed costs are the equivalent of Professor Eicher's total of the fixed costs plus the invariable costs. For the latter, fixed costs are initial capital costs (building construction, purchase of equipment) and the invariable costs are those which recur each year and which are not related to the number of units produced (management and administrative personnel, operational costs, etc.). The interest of distinguishing types of fixed costs lies in the fact that the first category are costs borne only once, whereas the second category represent costs recurring annually. In other words, in Professor Eicher's classification, from the technical point of view, one is able to reply to the questions:

1. What has to be paid? (Economic aspect)
2. When has it to be paid? (Financial aspect)
3. Who has to pay? (Institutional aspect)

Concerning the second point, it is apparent that many difficulties arise in attempting to categorize certain costs as fixed, invariable or variable. In particular, according to whether or not those promoting a project allow for depreciation of the building they are using, this cost goes from invariable to fixed costs (Eicher's terminology). If the buildings belong to a third party who is providing a service to a client, the building costs go from fixed costs to variable costs (viewpoint of Eicher and Oatey). This is the case, for example, in France, where the promotors of educational television programmes do not invest in the buildings which are used for programme production. They contact the national television service which takes account of depreciation of installations in its invoice. From the point of view of the promoter of educational television, this depreciation is a variable cost if the unit used is the programme-hour.

On this point, Mr Leclerc stated that the French Television services working in education make a distribution between direct and indirect costs. Direct costs are those which are directly engendered by the production of one hour of programme (film, tape, payment to directors and actors, etc.). Indirect costs are those which exist anyway, even if no programme is produced: depreciation of installations (buildings, studios, electronic equipment, etc.), permanent staff for maintenance and administration, etc. At first sight, this distinction is very close to that made between fixed and variable costs, the direct costs being variable costs, that is to say, those which vary with the number of hours of programmes produced. But, in reality, the distinction is not economic but institutional. For the purpose of international comparisons, cost studies relying on terminology of this type (direct-indirect) reflect not differences in cost, but institutional variations and are inappropriate. As an example of this problem, it is sufficient to note that in certain countries, producers are paid for each programme (variable costs) and in others, they are permanent employees (therefore representing fixed costs).

Innumerable other difficulties of the same sort were stressed by the participants in the meeting. There was a unanimous decision that for future studies, the so-called economic terminology should be abandoned as a method of comparison in favour of the technical and financial terminology.[1]

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[1] Several of the experts consulted expressed their regret that this method had been abandoned. What is involved is not, in fact, a cancellation but the adoption of a procedure designed to improve comparisons of economic costs. It is still possible, on the basis of a detailed technical classification, to calculate economic costs and to carry out comparative studies using the same methodology. On the other hand, nothing can be gained from comparing two studies of economic costs when the precise elements of the calculation (e.g. whether the variable costs include the amortization of the material) are unknown, since it is impossible to determine economic costs if economic costs are themselves taken as the starting-point. Participants in the meeting did not so much recommend abandoning the calculation of economic costs as stress the need, where a choice must be made between the technical and the economic terminology, to give preference to the former. In this way, subsequent comparisons with other monographic studies can be made, using the same method of calculating economic costs.

Terminology of the survey on the costs of programmed instruction

Harmonization between this terminology and the first synthesis formulated by the members of the group presents no difficulty. It offers wide possibilities for easy regrouping of all items in the four phases of the first synthesis: (a) conception costs; (b) production costs; (c) distribution costs; (d) utilization costs.

In this way, pre-production costs came to be included under conception costs. Training costs were considered as non-specific. In fact, training operations can appear in each of the four phases and in this case, the costs are included under the heading within each of these phases. Promotion costs have been regrouped with production costs.

For the third phase (distribution), a new distinction was proposed by the group according to the type of media used. The broadcasting of a one-hour television programme is very different from the distribution of projected or printed media which comprises two very distinct phases: (a) duplication of the document; and (b) circulation of the document.

Distribution
1. Broadcast: (a) transmission,
2. Non-broadcast: (b) duplication; (c) circulation.

Classification table of physical resources

Why physical resources instead of costs?

A statistical evaluation of resources needed in a given project only enables international inter-media comparisons (or inter-media systems) to be made if common units are used. The most usual method employed is the evaluation of resources mobilized with international monetary units which allows aggregation of heterogeneous resources. There again, one must be careful that the differences observed do not only reflect institutional or conjunctural differences. For example, the cost of manpower being less in developing countries, the lower cost of a technology implying utilization of abundant manpower should not be interpreted as the index of a more efficient technology.

In the same way, the very high cost of supplying power by battery for television receivers in certain African regions without electricity does not constitute a proof of the general non-competitivity of the technology in question.

For this reason, it seemed of high importance for the group to elaborate a standard table for identifying the resources of a system in physical terms. The costing in monetary terms may be made afterwards, but for the purpose of international comparison the physical resources should be calculated on homogeneous international standard costs, and for the purpose of decision-making on the basis of the standard costs of the country wishing to use a system. For example, cost of manpower or of transmission facilities vary from one country to another.

Proposed classification for listing physical resources

The proposed standard table should be established for the four technical categories identified above and which correspond to the development of a system:

A. Conception costs.
B. Production costs.
C. Distribution costs.
  C.1. Transmission.
  C.2. Duplication.
  C.3. Circulation.
D. Utilization costs.

Remarks

First, the table of physical resources is a necessary preliminary for comparing this programme to others. It goes without saying that budget

TABLE 2. Proposed standard

Number of hours × number of students: . . . × . . .			
1. Buildings of general nature	Area (m^2)	Hours of use per annum	Life expectancy (years)
2. Special buildings			
Studios	Area (m^2)	Hours of use per annum	Life expectancy (years)
Other	Area (m^2)	Hours of use per annum	Life expectancy (years)
3. Equipment and materials[1] per type	Quantity	Hours of use per annum	Life expectancy (years)
4. Consumable furniture and spare parts per type	Quantity		
5. Labour per qualifications[2]	In man-months per year		
6. Other resources			
Energy per type and mode of transmission		Quantity	
Other		Quantity	

[1] Transport vehicles should be noted here.
[2] Qualification should at least indicate the level of education received at four levels: without qualification, primary, secondary or higher education.

figures in the table will be indispensable in a second phase, it being understood that any such second stage would reflect only local scarcities and not those at an international level.

Second, it is difficult to isolate certain services in terms of physical resources. For example, if the transmission of one hour of educational television necessitates a satellite, the agency managing the latter will invoice the cost of one hour of use of a channel without indicating the nature and the quantity of material or ground personnel needed to operate the satellite. In such cases, the description in terms of physical resources should preferably figure under the heading 'other resources' entitled 'use of a satellite' indicating the number of hours in the 'quantity' column. However, services which are invoiced globally should be limited to a strict minimum, as otherwise one is unaware of the real resources mobilized and there is no way of controlling the process of fixing the final cost by those providing the service.

Third, in cases where the description of physical resources acting as a first approach to costing is not realistic, it will nearly always be found that this relates to complex technologies. Very often, these techniques call upon international standards for which the relative costs of the different resources are of a more homogeneous nature (i.e. one hour's use of a satellite channel does not depend to any great extent on local scarcities). Consequently, in such cases it is not really necessary to go into a physical description of the resources and it is quite feasible to use a monetary figure (in an international currency) as the cost unit.

Finally, another problem is created by the remuneration of artists or payment of copyright fees. From an economic point of view, these costs correspond to remuneration for a particular service. The group proposed the inclusion of these resources under the heading 'labour' even though that could pose problems at the level of evaluation of quantities (man-months). If that proves impossible, only the amount of copyright paid would be indicated.

Calculation of costs

Two kinds of cost units were worked out by the group:

Medium cost unit

The first concerns the medium itself: medium cost unit. This is normally an hourly cost: one hour of radio, television, cassette, records, film, etc.

However, for media without 'duration', in the case of printed documents, for example, the unit cost will be calculated by page. With slides, the unit cost will be calculated by slide.

The first cost will be called medium unit cost. For each of the four phases, the medium unit cost can be established per student to obtain the cost of the medium per student unit.

Student learning cost unit

The second concerns use of media in the educational process. This can be the same as the preceding case if it refers to an educational technology using a single continuous medium: for a one-hour lecture broadcast by radio, the student-learning cost unit and the medium cost unit will be the same. Most frequently, the cost will be different because one hour of film can be expanded to three hours of teaching and learning. It goes without saying that to compare economic performances of two media or two combinations of media (multi-media system) at a supposedly constant educational output, a unit of measure which will permit comparisons must be defined. This unit can only be the average hour of student learning.[1]

'Average' has been indicated because for certain media, such as the printed document or cassettes, the student can work alone: the length of time needed for acquisition of knowledge varies from student to student. The final unit cost will therefore be established from the average time needed to acquire the knowledge. This will be given either by the designer-producer of the programme unit, or by an empirical observation after operation of the system has commenced.

In conventional education, this corresponds to the time allocated both for direct teaching and self-instruction (homework). For instance, a teacher-training course which is based on thirty weeks with twenty-five hours of lectures and practicals and fifteen hours of study represents 1,200 average student learning hours.

This second type of unit cost will be called student learning unit cost.

Examples of calculation

Media unit cost (CT)

The medium cost should be established for each of the four phases ($C1$, $C2$, $C3$, $C4$). For all continuous media, a calculation of cost per hour will be sought. (For a record, it is not the cost of the record itself because the length of a record can vary and in this case the unit will not be homogeneous, but only the equivalent in records of one hour of listening time.)

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[1] Average hour of student learning: this is the time allocated by producers to achieve the learning objective of a unit.

For each of these phases, the cost of the student/medium unit can be calculated if N is the number of students aimed at by the technology studied, i.e.:

$$\frac{C1}{N} \quad \frac{C2}{N} \quad \frac{C3}{N} \quad \frac{C4}{N}.$$

Frequently, the number N of students is not the same for each phase. A project can be conceived, then produced for a target audience of 1 million students ($N1 = N2 = 1$ million). It will then be transmitted the first year to 200,000 students ($N3 = 200{,}000$). It will eventually be received by x classes of 25 students ($N4 = 25$). The total unit cost of the media per student thus becomes:

$$CT = \frac{C1}{N1} + \frac{C2}{N2} + \frac{C3}{N3} + \frac{C4}{N4}.$$

Student learning hour cost (CU)

Most often, a medium is not used on its own, but is integrated into a multi-media system which is organized around a programme unit. This programme unit will necessitate an average student attendance of 8 hours, which time will be split into 2 hours of television, 1 hour reading documents, 3 hours with a teacher and 2 hours using cassettes. This makes four different media, whose cost can be calculated as above:

C_{TT} = total cost per student per hour of television × number of hours of television;
C_{TD} = total cost per student per page of document × number of pages;
C_{TE} = total cost per student per hour of classroom teaching × number of hours;
C_{TC} = total cost per student per hour of cassette × number of hours.

The total cost of the programme unit per student is thus equal to:

$$CT_P = x\,C_{TT} + x\,C_{TD} + x\,C_{TE} + x\,C_{TC}.$$

Cost per student learning hour will be the ratio between total cost of a programme unit per student and the average number of hours *(H)* necessary for a student to learn from it:

$$CU = \frac{CT_P}{H}.$$

A computation of this type enables comparison of all the media, and all possible combinations of media, in whatever programme unit, whatever its duration.

Identification of media systems

In order to allow quick identification of media systems, the group proposed the following matrix to be used as a first part of each cost study.

Table 3. Proposed matrix for identification of media systems

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1. ***Framework of the system***
    1. Origin
    2. Aims (of the promotors)
    3. General context, in relation (a) to educational system (formal or non-formal); (b) to social and cultural environment
    4. Date of the decision to create system
    5. Starting date
    6. Period covered by the analysis
2. ***Objectives***
    1. Initial objectives
    2. Secondary objectives
    3. Evolution
3. ***Population***
    1. Target population
    2. Actual population—please specify for each: (a) size; (b) socio-professional categories; (c) geographical distribution.
4. ***Institutional framework***
    1. Institutional responsibility
    2. Statutes
    3. Executing agencies for the different phases and components of the system: design; production; distribution; utilization; evaluation
5. ***Educational content***
    Educational aims; subject; levels. Certification and control. Programming, schedule; duration
6. ***Modes of reception and utilization of the (multi-)media system***
    Group/individual reception.
    Captive/non-captive reception
    Nature and training of tutors or teachers
    How is the work organized at the student level; combination of different media and different teaching-learning situations (class situation, seminar, self-learning, tutoring, etc.)
    Describe one unit of the (multi-)media system (type of media used; specific roles; duration or number of pages for each)
    Total learning time (average or proposed by producer) induced by one unit of the system
7. ***Evaluation***
    Who is in charge of: (a) formative evaluation; (b) summative evaluation?
    Results: (a) in relation to the objectives; (b) in relation to the educational environment
    Difficulties encountered

Institutions and experts

Directory of specialized institutions and experts

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Centre de Recherches Appliquées,
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Classification grids

The following two grids were proposed: Grid A, following the working group meeting of April 1974; and Grid B, following a further meeting of the same group in June 1975.

Both were experimental and did not prove applicable. Consequently the question remains open for a further meeting.

Classification Grid A (five digits), 1974

Type of study (1 digit)	Type of situation (1 digit)	Media (3 digits)
1. General or methodological studies.	0. Not applicable.	0. Not applicable.
2. Isolated media.	1. Existing situation	1. Printed media.
3. Combined media.	2. Hypothetical.	2. Other non-projected media.
4. Systems.		3. Still projection
5. Management and services.		4. Motion film
6. Effectiveness studies.		5. Sound media.
		6. Radio.
		7. Television.
		8. Computer.
		9. Others.

Example: 41.761 is a systems study (4) of an existing situation (1), covering television (7) and radio (6) and presented in printed form (1).

Classification Grid B (four digits), 1975

Type of situation (1 digit)	Type of media (3 digits)
0. Not applicable.	000. Not applicable.
1. Existing situation.	1. Non-projected media (including printed).
2. Hypothetical situation.	2. Projected media.
	3. Sound media.
	4. Tutoring.
	5. Radio.
	6. Television.
	7. Computer.
	8. Multi-media.
	9. Others.

The figure 0 in the third-digit position indicates a comparison, e.g.: 1.602 = comparison between television and film.

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Abstracts

Origin

Unesco.

Authors

SCHRAMM, W. *et al.*

Title

What Do the New Media Cost? In: *The New Media: Memo to Educational Planners*, p. 119–57.

Bibliographical description

Paris, Unesco: IIEP, 1967.

Subject analysis

Importance and difficulty of costing. Terms and allocation of costs. Behaviour pattern of cost elements. Start-up expenses and operating costs. Unit costs. An example of how one can economize.

Contents analysis

In this chapter, after a few preliminary notes on costs and costing and the terms used in talking about them, the authors consider the order of magnitude of costs to be expected from different kinds of media projects, then turn to the unit costs and the problem of managing them efficiently, and finally take up an old and much debated question: can the educational media save money?

The difficulty in costing arises in the fact-finding. There is often a difference between budgetary costs and total costs, which may arise from differences in the methods of financing the projects in question.

Costs have been broken down in the traditional way: (a) production (including administration); (b) transmission (or distribution); (c) reception.

The allocation of costs that are not one or the other is decided empirically on the ground. Definitions are proposed for each item and the relevant costs, namely: *capital investments*—expenditure on equipment, buildings, electrification, furniture and similar items that are not short-run current costs; *operating costs*—all expenditure needed to keep the project running; *capital charges*—depreciation on the investments made and a notional interest charge on investments; *unit costs*—considered in terms of both costs per student and costs per student-hour.

A distinction is drawn between fixed and variable costs. Fixed costs are those that are insensitive to an increase in the number of students or the number of programme hours. Variable costs of programme production, administration and transmission may be variable with the number of students or with the number of programme-hours produced and distributed. They may or may not vary proportionately. But the bulk of costs for these functions varies with the number of programme-hours produced and transmitted. Reception costs are also divided into fixed and variable costs. The behaviour pattern of certain costs and the combination of factors are referred to, as is their influence on the efficiency of the new media.

Having defined the meaning of the terms used, the study deals with the main questions which planners have to answer concerning the cost of projects based on the use of the new media. The study sets out, with the support of figures and of illustrative examples taken from actual projects (Hagerstown, Ibadan, MPATI, Peru, American Samoa, Honduras, Thailand) the following cost items for educational radio and television: (a) start-up costs; (b) operating costs; (c) unit costs (school broadcasting, teacher training).

The relative efficiency of different projects cannot be compared. The study discusses the potential contribution of size and design to the efficiency of a project, including the following points: (a) manpower and productivity; (b) financial break-even point; (c) expanding a project.

Citing an example, the authors show how economic decisions are arrived at during the planning of an educational television programme.

The questions which the educator is likely to put to the economist are the following:

1. What teacher manpower will be required for a television project?
2. How can the project be organized so as to meet the stated requirements at minimum cost?
3. How much approximately will the project cost?
4. How can it be economically expended to serve adult viewers?

The authors conclude that the extraordinary variability of the costs of new media projects is apparent. Part of the variability of these costs depends upon salary and price structure. More, however, depends upon the size of the project, how large an audience it serves, and the cost-efficiency of the balance between reception cost and production-transmission cost.

Most of the projects observed under-use the media; if they could expand their services to more users, or to more programmes, or to both, they could operate a great deal more cheaply in terms of unit cost. If receivers were used to a maximum, and with audiences numbering hundreds of thousands, it would be theoretically possible to reduce costs for intructional television broadcasting to as little as 1–5 cents per student-hour.

Radio data are too limited to generalize, but it looks as though radio costs per student-hour might be of the order of one-third to one-fifth as much as television used under comparable conditions. From the experience of several countries, correspondence-plus-broadcast teaching can be offered at a cost which is sometimes a little lower than, sometimes a little above, the ordinary cost of classroom instruction in densely populated areas.

Do the new educational media save money? This is a very complex question, requiring the measurement of quantitative cost against things not so easily quantified: the quality of education, for example. Media projects will rarely save over present budgets, but often make possible a substantial saving in the context of growth and change—when a school system is planning to change a curriculum, offer new and different subjects, extend its services to persons or places where education has not before been available, or to bring more people into the company of literate and educated persons.

Sample current-cost sheets are set out in an appendix.

Origin

France.

Author

Bureau d'Études Technico-économiques Appliquées à l'Enseignement Audio-visuel (BETEA).

Title

Étude Comparée de la Rentabilité Économique des Différents Systèmes d'Emploi Différé sur Bande Magnétique des Émissions de la Radio Scolaire.

Bibliographical description

Paris, BETEA, September 1968, 44 p. (Étude No. 5/1968.)

Subject analysis

Research into actual classroom use of magnetic tape. Comparison of radio broadcasting and use of recordings. Analysis of the different solutions. Cost study. Comparison.

Contents analysis

This is not a prospective study, but a survey designed to provide immediate guidance for short- and medium-term choices governing the solution of specific problems. The study therefore takes the following factors into account: first, the state of schools broadcasting in France (and its evolution over the next five years); second, priority action areas; finally, what is known from experience about the extent to which a production activity can be absorbed within an administrative sector.

The underlying principle is not to discover how, at the lowest possible cost, the maximum possible number of pupils can benefit from the use of a tape recording in the classroom, but how to achieve, at the most reasonable cost, an effective classroom use of the tape recording. Experience has in fact clearly demonstrated that tape recordings are not necessarily used even when they are available.

The subject is governed by three factors: (a) *the broadcast*—at the present time, it may be taken that radio broadcasting of school programmes by frequency modulation provides the most satisfactory standards of quality, standards which tape recordings must at least approach; (b) *reception*—the study is more specifically concerned with lower secondary education; it has rapidly become apparent that demand is greatest at this level; (c) *the state of the art of magnetic recording*—cassette recording is for the time being excluded.

The present study, carried out in April 1968, included visits to five regional Centres for teaching documentation—in Lille, Strasbourg, Bordeaux, Poitiers and Clermont-Ferrand—for the purpose of: first, studying the working of systems for the tape recording of broadcasts and their distribution, as set up by each centre, whether on its own initiative or as a result of consumer demand; second, estimating in free discussion with those in charge the nature and volume of the needs expressed; third, identifying the obstacles of all kinds (whether financial, technical, practical, educational or psychological) which still hamper the development of such activities.

After a comparative approach to radio broadcasting and the use of recordings (the limitations of broadcasting and the fluctuations in the demand for tape recordings), various solutions for the recording and distribution of tapes are analysed: distribution by a central body; regional distribution; local recording and distribution.

Distribution by a central body is characterized by a certain dilatoriness in meeting requests, wastage due to the fluctuation of requests and steadily rising administrative and management costs.

Regional distribution often develops spontaneously at the instigation of users. The various methods of recording and distribution are analysed (types of tape recorders, subscription systems and arrangements for the circulation of tapes, the technical quality of reproduction equipment).

Local recording and distribution are then looked into (quality of the copies, qualifications of staff, safety of the equipment and means of dealing with breakdowns).

In the general study, the costs of recording and distribution are compared according to the length of time for which programmes are to be used (one year, three years, six years) and the periods for which they are distributed to individual establishments (fortnight, three months, one year).

The advantages of the regional and local systems are then compared in relation to 'unit cost per series' and 'unit cost per pupil'. The 'non-economic factors influencing profitability' and the 'foreseeable future of systems' are also considered.

The report demonstrates that regional recording, with subsequent distribution for three-month periods, is the most advantageous solution, i.e. the one which best meets the teaching, practical and financial requirements.

Individual recordings and use are still the most economical solution, but the practical limitations of this system—the most demanding on the teacher—militate against its general application. The study closes with a series of conclusions and recommendations: from a short-term point of view, the possibility of State assistance for what is being done in this field by schools and by the regional centres for teaching documentation; from a long-term point of view, the regionalization of production and research, more precise selection of sectors where schools broadcasting can usefully contribute, a change of attitude on the part of teachers. Reports on the visits to the various regional centres are annexed.

Origin
France.
Author
Bureau d'Études Technico-économiques Appliquées à l'Enseignement Audio-visuel (BETEA).
Title
Étude Économique des Différents Types de Circuits de Télévision Intégrés dans les Établissements Scolaires.
Bibliographical description
Paris, BETEA, December 1969. 53 p. (Étude No. 1/1969.)
Subject analysis
Audio-visual distribution network. Local production circuit. Costs of equipment, operation and utilization. Comparative costs.
Contents analysis
The expenses incurred by an educational establishment in operating a closed television circuit are, by and large, underestimated and not precisely known. They fall under several budgetary heads: remuneration of teachers on the permanent staff; remuneration of teachers recruited specially for the purpose; various documentary materials; costs of replacing spare parts and maintenance, paid from budget funds, and so forth. This is the reason why the sum total of these costs has long remained a relatively unknown quantity.

In the case of all new installations to be set up, it proved necessary to replace estimates of uneven quality by precise evaluations: this is the purpose of the study carried out in 1969.

The study covered several establishments previously equipped with closed television circuits: *collèges d'enseignement secondaire*, technical and classical *lycées* located in Paris itself and in the Paris region.

The method employed was to evaluate, in addition to capital expenses, the aggregate annual operating costs. The particularly straightforward case of the so-called demonstration circuits and the highly specialized teacher observation circuits were purposely disregarded, and the study concentrated on the two main cases: (a) audio-visual distribution network; and (b) local production circuit, linked to the preceding case.

Basic assumptions. The production circuit is assumed to produce at present some 300 sequences each lasting fifteen to twenty minutes, divided up, for the purposes of the assumption, in the following way: 40 per cent documentary productions, with commentary off; 30 per cent similar productions, with comments by the teacher alternating with the documentary material; 5–10 per cent original productions put together in the studio; 20 per cent studio discussion-type productions, involving several persons; 5–10 per cent full-fledged artistic or drama productions.

The production studio can be equipped with either of the following two types of equipment: either sophisticated, hand-operated equipment, providing high-quality pictures when operated by highly skilled professional personnel; or simpler, semi-automatic equipment, requiring a smaller and technically less highly trained crew to operate.

Together with average equipment costs, the study gives a breakdown of the total annual operating costs.

Capital costs. It is assumed in each case that the pictures and sound track are transmitted to twenty specially equipped classrooms. The capital costs itemized in detail (equipment for aerial reception, document scanning devices, film shooting, visual and sound tape recording, lighting, etc.) total approximately:

200,000 French francs in the case of an audio-visual distribution network;

500,000 French francs in the case of a local production circuit.

Annual operating expenses. The largest share of these expenses is, of course, accounted for by remuneration of personnel, which runs from 50,000 French francs (distribution network) to 420,000 French francs (production circuit). To these must be added documentation expenses, costs of preparation (graphic work, scenery, photography, film, etc.), technical operating expenses (expendable material, replacements, electric current, tapes, upkeep), etc.

The annual total, staffing costs included, ranges from 85,000 French francs (audio-visual distribution network) to 400,000–500,000 French francs (production circuit).

For the sake of obtaining a full annual balance sheet, there should be added to these figures the annual costs of amortization, respectively 21,000 French francs and 60,000 French francs.

From the foregoing it may be deduced that: the production circuit is two and a half times more expensive to set up than the distribution circuit, and approximately five times more expensive to operate; annual operating expenses may come close to the cost of the initial equipment.

These figures show how essential it is to ensure, before proceeding to install a production network, that funds will be available to cover future operating costs. It is also important to set up a circuit for the circulation of locally produced programmes, designed to enable all peripheral education establishments to benefit therefrom.

Origin

France.

Author

Bureau d'Études Technico-Économiques Appliquées à l'Enseignement Audio-visuel (BETEA).

Title

Comparaison entre la Diffusion par Film et par Télévision.

Bibliographical description.

Paris, BETEA, June 1971. 51 p. (Étude No. A4/1970.)

Subject analysis

A comparative study is made of two types of broadcasting: film and television. Comparison of costs is based on a 'group' of pupils, variable in number (from five to forty or more) according to subject and level.

Contents analysis

Chapter 1 of the report evaluates the number of prints required by a central film library. The problem is a complex one since several factors are involved, some of them variable, such as: the number of establishments and the distribution of pupils in groups at a particular level; the different programming requirements implicit in the film medium, which may or may not allow a film to be shown at any time of the year; the useful teaching life of a film, which depends on its content.

Chapter 2 contains a study of the cost of film libraries. The overhead costs of a film library do not increase in linear fashion according to the number of prints distributed each year.

Spread over each print, overheads are relatively higher for a small film library than for a very large one. Operating costs are evaluated for three different cases: 20,000 prints; 50,000 prints; 150,000 prints.

Calculation for the second case: annual building and equipment costs amount to 10,000 francs. Annual staff costs come to 250,000 francs.

A table on page 14 of the text indicates, for all three cases, requirements and annual running costs. It emerges that expenditure is not proportional to the number of prints.

The cost of projecting a film for a group of pupils is the sum of three elements: film library overheads; postal charges; amortization of the print.

The following parameters are used in this chapter: N = number of establishments served; E = period of useful service of a film during the school year (in weeks); D = length of lending cycle from the date on which the print leaves the film library until its return (in weeks); X = number of identical prints to be stocked by the film library; A = amortization period of the film (worn out after 300 screenings); Y = average number of borrowings or screenings of each print annually.

The following general formulae are obtained:

$$X = N : \frac{E}{D} = \frac{N \times D}{E} \text{ and } A = \frac{300 \times D}{E \times Y} \text{ years.}$$

If the curves obtained by orthogonal affinity are represented on a graph, the following data can be obtained: (a) the amortization period A, in terms of the annual utilization period E and the average number of screenings Y in each establishment; (b) the number of prints X required to supply all establishments as a function of E.

Chapter 3 contains a study of the comparative theoretical cost of television and film broadcasting per group of pupils. A twenty-minute television broadcast costs 3,525 francs per group. If it is designed for a specific lower-secondary level (20,000 groups, of which only 5,000 can view it unless recordings are made), the cost per group comes to 3,525 : 5,000 = 0.70 francs.

At a unit cost of 0.97 francs per television broadcast (without repeats), film is more economical when the annual utilization period (E) attains ten weeks, provided that the useful teaching life is at least: three years, when $Y = 20$ or six years, when $Y = 10$.

When E falls between six and ten weeks, film and television costs are very close; the difference is not sufficient to influence the choice.

The final chapter contains a study of the respective merits of Super 8 and television. A television broadcast (unless taped) can reach at most one-quarter of the student groups involved, whereas a film can be viewed by all (assuming that the best possible equipment is available in both cases).

The two systems are complementary rather than competitive. Quite apart from any teaching requirements, a general distribution of Super 8 film projectors could not at the present time fully replace television receivers.

Origin

United States.

Authors

Rhode, William E.; Esseff, Peter J.; Pusin, Carol J.; Quirk, Frank B.; Shulik, Rubin.

Title

Review and Assessment of Selected Instructional Media. In: *Analysis and Approach to the Development of an Advanced Multi-media Instructional System*,
Vol. I, Section III.

Bibliographical description

Ohio Air Force Systems Command, Wright-Patterson Air Force Base, May 1970. 419 p. (Distributed by NTIS, United States Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151.)

Subject analysis

In order to examine the possibilities for an advanced multi-media instructional system, this study begins with a comprehensive review and assessment of current instructional media in terms of functional description, instructional flexibility, support requirements, and costs.

This analytic study is directed toward the fundamental problem of instructional technology today, that of finding ways to significantly reduce instructional cost while either maintaining or improving instructional effectiveness.

Contents analysis

A chapter of this study provides a detailed description, review and assessment of each medium selected for analysis (i.e. portable instructor aids, television in education and training, portable videotape recordings, student-response systems, dial access information-retrieval systems, learning laboratories, programmed instruction by text, programmed instruction by teaching machine, learner-centred audio-visual devices, and simulators. Each medium except the last is described and carefully examined (often in multiple forms) as to instructional flexibility, conditions of utilization; and initial and operational costs under ideal combinations of instructional load and course frequency. (The basic cost estimates on which these cost analyses are prepared are tabled in a separate section of the report.)

Section III of the report contains summary cost sheets (amortized) on media treated in this study except simulators and other advanced equipment. Comprehensive cost specifications from which these summary costs are drawn can be found in Appendix III (Vol. 2) which includes the estimated non-amortized costs for each medium.

There are three summary cost sheets for each medium. The first deals with student-hour costs. These are shown for three different student-load levels, i.e. 200, 600, and 1,800 students, and for three different hour-load levels (duration), i.e. 150, 450 and 1,350 hours. Summary costs are based upon the total initial and operational amortized costs; learning materials production (LMP) for each specific item is based upon all costs associated with actual production. Initial, operational, and specific items costs are also represented as percentages of the summary cost.

Total student-hours produced for each level comprise the total number of students (200, multiplied by the total number of hours of instruction required of each student (1,350) which yields 270,000 student-hours).

The second summary table, dealing with amortized production costs, presents initial and operational amortized costs incurred in the production of the original, or master, set of learning materials for the three-hour load levels (150, 450 and 1,350 hours).

The third summary table deals with amortized distribution, reception and maintenance costs and presents initial and operational amortized costs incurred in the distribution and reception of 150 hours of learning materials for 200, 600 and 1,800 students. Costs incurred in the distribution and reception of 450 and 1,350 hours of instruction are found in Appendix III.

The following tables are included in order to provide a comparison of the media discussed in this chapter: Table 78: Instruction flexibility of various media; Table 79: Support requirements of various media; Table 80: Student-hour costs of various media; Table 81: Learning materials production costs per hour amortized; Table 82: Learning materials production costs per hours non-amortized.

In conclusion, it seems evident that, even if the advanced multimedia system suggested is never built, the report will continue to be of value. Nowhere else is there currently so much data, particularly on costs, regarding differing instructional means. Consequently, anyone concerned with the design of instructional systems should find the report a valuable aid.

Origin
Unesco/IIEP.
Author
HALLAK, J.
Title
L'Analyse Coût/Performance dans la Planification des Programmes Audio-visuels, p. 47–52.
Bibliographical description
ICEM/Unesco, Rapport de INTER NAVEX 70, World Conference.
Subject analysis
Methodological and practical problems in the cost/performance analysis of audio-visual systems. Multi-dimensional nature of educational output. Case studies. Forecasting performance differences.

Contents analysis

The report analyses a communication presented to the World Conference on the Management and Planning of Audio-visual Media, London, July 1970.

Since success in a particular branch of education cannot be evaluated solely in monetary terms, cost/performance analysis is preferable to cost/benefit analysis.

The *methodological difficulties* involved in applying cost/performance analysis to education programmes are, however, legion and appear at different stages:

First, performance is difficult to estimate: educational programmes generally have different goals at the same time, and these are rarely defined with any great precision. In order to measure the performance of a programme, the average performance in relation to each goal has to be calculated, and there is no reason to think that one weighting system alone is valid. Furthermore, the effects of an education system may be spread over many years, and they have to be distinguished from the effects of other social programmes. In an over-all social programme, how can the effect due to education be isolated?

Second, cost estimating is linked to problems of definition (real, budgetary, economic, direct or indirect, variable and residual costs), with problems of allocation (between different projects, between categories of costs, between costs payable at different times) and with problems of estimation (implied costs, bank rate, present value of deferred costs).

Two examples illustrate the practical problems involved. In the Ivory Coast, a study of the use of television in primary schools showed that costs would be increased by 40–50 per cent per pupil/year. The government nevertheless chose television which, in this specific instance, was not meant merely to improve output but to facilitate the rapid introduction of new curricula and reform of the education system as well as to help counter the drift to the towns.

The second example concerns four secondary-level systems in Japan: full-time, part-time, correspondence and television, and radio. The comparative cost study showed that audio-visual methods were highly competitive. In practice, however, various adjustments had to be made because students following the traditional system took three years, while those studying by means of broadcasts and correspondence needed four years to complete the same curriculum. It also emerged that students in the traditional system were generally of a higher standard and that the dropout rate was much greater in correspondence courses. Radio or television was therefore used to bring the standards of students destined for the various systems closer together, to reduce dropout and to obtain better results.

The second part of the study deals with two experiments in the application of the cost/performance method: first, a classification of the equipment used by order of efficiency (for this purpose, it is desirable to develop a graduated scale on the basis of expert advice); second, a report by the author on a comparative study of three educational television systems (Niger, Samoa, El Salvador).

The investigators took twenty-one criteria into consideration, including educational reform, economic development, the relation between education and the local environment, stimulation of creativity, development of the personality, teacher/pupil relations, productivity, production and reception, etc. Each criterion was assigned a weight (from 1 to 4). While permitting comparisons, this analytic technique does not eliminate the danger of systematization.

A further example of the use of this method concerns the choice between different television systems: video, short wave, retransmission by satellite and direct satellite transmission.

In this connexion, the author stresses the need to take account of non-economic factors, such as social and political considerations, as well as economic factors.

Origin

United Kingdom.

Authors

Vaizey, John; Hewton, Eric; Norris, Keith.

Title

The Costs of the New Educational Technologies.

Bibliographical description

Lisbon, Centro de Economia e Finanças, 1971. 108 p.

Subject analysis

Cost studies on television, programmed instruction, and learning packages. Unit costs and total additional costs to schools. Costing methodology. Cost tables, economies of scale. Suggested benefits.

Contents analysis

A series of studies on the actual and projected costs of using local transmitted ETV, programmed instruction and teaching machines, and learning packages in secondary schools.

The authors hold to a very conservative assumption: that the effects of educational innovation are nil, i.e. outputs remain constant. The studies simply measure the additional cost of the innovation. However, there is strong evidence that the effects are positive; and some possible benefits are suggested which the educator may consider when making judgements on whether the extra cost is worth while.

In all studies, costs are tabulated in detail and classified as capital and current. Cost items include: buildings, equipment, consumable materials, development, hire, maintenance, technical and administrative staff, etc. The basis for accounting for capital building, equipment and development costs is stated, including the amortization period. In some studies, cost adjustments are made depending on assumptions concerning the cost of space, the amortization period and staff costs.

Total costs of secondary schools for 1968/69 are quoted. An allocation between subject costs is made, which solely reflects differences in time-table allocation; this is done to provide a rough notion of subject costs, but the assumption is not crucial to the cost studies.

Three television systems. The first studies report the annual costs for 1968/69 of local transmitted ETV services in three cities, in terms of: total cost per school, cost per school pupil, cost per programme-hour, and cost per student-hour. Projections are made for 1970/71 at higher rates of activity. The television services result in an additional cost per school pupil varying from 1.2 to 1.8 per cent.

Innovations on a small scale. These two studies refer to programmed instruction. The first study considers the use of 110 branching teaching machines to teach mathematics in one school in 1968/69. Such a system is clearly not viable in one school on cost grounds, even allowing for a possible reduction in staff due to the use of combined classes. A second study analyses the costs of teaching biology in a school using programmed texts and film loops, in 1968/69.

An innovation on a large scale. This last study reports the costs during 1968/69 of a group of teachers working full time preparing materials for learning packages for secondary schools, as part of the Nuffield Resources for Learning Project. The packages consist mainly of booklets and audiotapes.

The conclusion of the report emphasizes that effectiveness has not been considered. No measure of effectiveness exists for the experiments considered. For this type of study, there seems little possibility of using earnings differentials to evaluate output, and cost-effectiveness analysis is the appropriate technique. Justification for innovation might be found in areas where there are too few teachers, or where teacher performance is poor, or where the subject inherently demands presentation in a way that a teacher, without aid, cannot offer.

Origin
United Kingdom.
Authors
Vaizey, John; Hewton, Eric; Norris, Keith.
Title
Three Television Systems. In: *The Costs of New Educational Technologies*, Chap. III, p. 23–53.

TABLE 4. Inner London Educational Television Service

School year	Unit costs (£)			
	Per school	Per pupil per annum	Per programme-hour	Per pupil-hour
1968/69[1]	967[2]	2.20[3]	3,620	0.56
1971/72[4]	523[5]	1.53[6]	3,978	0.13

1. Actual costs.
2. For 254 schools.
3. For 112,000 pupils.
4. Estimated costs.
5. For 300 schools.
6. For 450,000 pupils.

TABLE 5. Plymouth Educational Television Service

School year	Unit costs (£)			
	Per school	Per pupil per annum	Per programme-hour	Per pupil-hour
1968/69[1]	517[2]	1.79[3]	1,581	1.90
1970/71[4]	497[5]	1.72[6]	1,137	1.37

1. Actual costs.
2. For 110 schools.
3. For 32,000 pupils.
4. Estimated costs.
5. For 128 schools.
6. For 37,000 pupils.

Bibliographical description

Lisbon, Centro de Economia e Finanças, 1971.

Subject analysis

Cost study of three school television systems in the United Kingdom.

Contents analysis

The systems are located in London, Plymouth and Glasgow. The costs calculated are the annual costs for the school year 1968/69, with projections for 1970/71 and 1971/72.

It will be noted that the number of pupils strongly influences the unit costs. A problem however arises with regard to the estimated capital costs, since the production premises were provisionally installed in low-cost municipal buildings.

It will be noted that, as a result of the number of pupils involved, the cost per pupil-hour is nine times higher than in the previous case, in spite of production costs being three times lower.

TABLE 6. Glasgow Educational Television Service

School year	Unit costs (£)			
	Per school	Per pupil per annum	Per programme-hour	Per pupil-hour
1968/69[1]	543[2]	1.40[3]	869	0.13
1970/71[4]	762[5]	1.97[6]	886	0.185

1. Actual costs.
2. For 299 schools.
3. For 116,000 pupils.
4. Estimated costs.
5. For 325 schools.
6. For 125,000 pupils.

These systems are difficult to compare since they use different methods and are centred on different permanent facilities, the costs of which are often impossible to evaluate (how should the cost of very old buildings be reckoned?)

Nevertheless, the unit cost per pupil-hour is always higher than it is in conventional education, where it amounts to £0.12. It is important to note the strong influence of the number of pupils on unit costs; in this respect, the Plymouth experiment was severely handicapped.

Origin

United Kingdom.

Authors

VAIZEY, John; HEWTON, Eric; NORRIS, Keith.

Title

Innovations on a Small Scale. In: *The Costs of New Educational Technologies*, Chap. IV, p. 55–70.

Bibliographical description

Lisbon, Centro de Economia e Finanças, 1971.

Subject analysis

Description of two small-scale experiments carried out by highly enthusiastic teams of teachers, one of them using the Autotutor machine, the other printed documents and experimental material (for the teaching of biology).

Contents analysis

The first experiment concerns the use of the Autotutor for mathematics teaching (500 pupils and 110 machines).

The total annual cost came to £10,286 (1968/69), i.e. approximately £20 per pupil. If the experiment was extended to cover all mathematics teaching and all pupils at the school, the cost would increase by 22 per cent. The pedagogical performance of the system was not evaluated. According to the authors, the experiment is to be recommended only in cases where there is a lack of maths teachers.

The second experiment concerns the teaching of biology (315 pupils).

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This is an experiment in individual learning, during which the pupils are provided with printed documents, experimental material for carrying out practical work and films which can be viewed individually or in groups. The order of presentation of the curriculum is similar to that of programmed instruction, but with some 50 per cent traditional classroom teaching. The additional unit cost amounts to £3.86 per year. If the experiment was extended to 16,000 pupils, the additional unit cost would fall to £0.63, i.e. 14 per cent more than traditional instruction. The pedagogical value of the experiment was not evaluated. Among the advantages are that crowding in the laboratory can be avoided and the shortage of qualified teachers relieved.

Origin

United Kingdom.

Authors

VAIZEY, John; HEWTON, Eric; NORRIS, Keith.

Title

An Innovation on a Large Scale: the 'Hive'. In: *The Costs of New Educational Technologies*, Chap. V, p. 71–106.

Bibliographical description

Lisbon, Centro de Economia e Finanças, 1971.

Subject analysis

Calculation of the cost of a programme designed to develop rational curricula for a large number of pupils, including a variety of teaching materials: printed documents, slides, tapes, films.

Contents analysis

The 'Hive' is a group of teachers responsible for designing a complete and coherent educational programme, using all appropriate printed and audio-visual aids.

All the means used for a particular subject are called the 'package'. The subjects involved are maths, English, science, French and social studies. The selected level is secondary education.

In 1968/69 the cost of the group of teachers responsible for preparing the packages for one year of secondary education came to £23,613.

The schools participating in the project themselves bear the additional costs of equipment and supplies. These amount, per year and per pupil, to £1.26 for maths, £2.16 for English, £2.23 for science, £1.90 for French and £1.75 for social studies.

The authors have examined the effects of economies of scale. According to their estimates, additional unit costs would be divided by three if the number of pupils rose from 1,000 to 10,000.

This type of teaching is therefore more expensive than conventional instruction. It is justified to the extent that the pedagogical gains outweigh the additional cost. Such an evaluation has not yet been made in any methodical way, since the system is still evolving.

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Origin
United Kingdom.
Author
Oatey, M. J.
Title
Effectiveness and Costs of Instructional Media.
Bibliographical description
Staines Air Transport and Travel Industry Training Board, 1972. 58 p. (Research Report 72/1.)
Subject analysis
Report on an approach to media selection. Media and the effectiveness of instruction. Media characteristics. Costs and cost-effectiveness. Cost analyses. Exercises illustrating cost analyses. Media development and testing. Cost tables, bibliography.
Contents analysis

This report is based on research supported by British European Airways and the Air Transport and Travel Industry Training Board over the period 1968 to 1971. It describes an approach to media selection for vocational training, with particular reference to cost-effectiveness of instructional media.

When designing cost-effective instruction it is important to separate clearly decisions on media from those on methods—in practice the need for a strict distinction is not generally recognized. Media are the physical source of stimuli presented to the learner, and include the live instructor as well as videotape, slides, paper, blackboard, etc. Methods determine the stimuli presented to the learner (by media) and the responses and activities of the learner. A list of method 'factors' can be drawn up and used as a basis for making decisions on methods, e.g. visual motion, visual display area, motor responses, learner questions, pacing, feedback.

It is methods rather than media that determine the effectiveness of instruction. A clear separation can avoid the danger of media rather than instructional objectives dictating methods.

In addition, after making a rigorous methods/media distinction it can be seen that the media are more versatile than is commonly supposed; and that for any given instructional objective there will often be several media combinations that can achieve it. When there is such a choice, the least costly combination should be selected.

The report next considers production and presentation. Nine 'steps of production' are outlined, which are designed to provide a basis for the estimation and control of media production costs. The idea of production 'complexity' is introduced; and accounting for updating costs is also discussed here.

The relative costs of media in any given situation will depend on the amount and type of instructional content that needs to be produced, measured in terms of the number of instructional segments (s), and how often each segment is presented or repeated—this, in turn, being measured in terms of number of presentations per segment (p).

Costs are classified by behaviour, and the following categories have been found useful: master costs (M) which depend on content design and production; duplicate costs (D) which depend on taking duplicates from the master; and presentation costs (P) which depend on presenting the content of the duplicates to learners. Each category is divided into fixed (f) and variable (v) components with respect to numbers of segments, duplicates and presentations respectively.

To take a simple example, if s is the number of segments in a project, M_f the fixed master cost and M_v the variable master cost, then total master costs are: $M = M_f + sM_v$. Similarly if the number of presentations per segment is p, the fixed presentation cost P_f, and Pv the cost per presentation, then total presentation costs are $P = P_f + spP_v$. Thus total project costs are:

$$M_f + P_f + sM_v + spP_v.$$

Such formulae can be shown graphically and used to find break-even points between different media combinations.

Seven illustrative exercises are given, based on a hypothetical two-week course on clerical procedures which is presented twenty times a year. The media compared are the live instructor, videotape, slide-tape and paper; and both effectiveness, in terms of method factors, and costs are analysed. Exercises also consider sensitivity analyses, updating cost and centralized *v.* decentralized training. Graphs show the variation of costs with number of presentations. Cost tables show a detailed breakdown of costs, covering items such as equipment, maintenance, materials, labour, transportation, rental, and the steps of production.

Having estimated the media combination involving the least cost, the next step is to carry out practical tests in a learning situation. At this stage the possibility of substituting other media should still be considered. Such tests can also be used to check cost estimates, check on feasibility and practicability, evaluate effectiveness, and evaluate learner and instructor attitudes.

Origin
United Kingdom.
Author
WAGNER, L.
Title
The Economics of the Open University. In: *Higher Education*, Vol. 1, No. 2, May 1972, p. 159–83.
Subject analysis
Article on cost structure of the Open University compared to conven-

tional universities in the United Kingdom. Problems in making the comparison. Cost figures. Nature of the Open University teaching system and economies of scale.

Contents analysis

The paper makes cost comparisons between the Open University and conventional universities in order to give a broad indication of the cost differences between the two types of institution in teaching students and producing graduates.

Conceptual and statistical problems in making the comparison are explained under the headings: costs and benefits; teaching and research; standardized inputs; ex-post and ex-ante; price index; productivity changes.

The Open University teaching system consists of: correspondence material, television, radio, class tuition, and summer schools. The high fixed-to-variable cost ratio is emphasized: the only major items varying with number of students are correspondence materials production and postage, and personal tuition. By contrast, the largest single item in recurrent expenditure of conventional universities—academic salaries—is directly linked to the number of students.

The paper makes four cost comparisons. These are the average recurrent cost per equivalent undergraduate which, in the Open University, is little more than a quarter of conventional universities; the capital cost per student place where the Open University figure is about 6 per cent of the conventional figure; the average recurrent cost per graduate which indicates that the costs of the two types of institution would be equalized if the Open University had an 85 per cent drop out rate; and the resource cost per equivalent undergraduate where the Open University costs are about a sixth of those in conventional universities.

Even when allowances are made for different research proportions, the Open University seems to have an advantage. The paper makes a tentative suggestion that it is not the part-time nature of the students but the method of teaching at the Open University which gives it the advantage. The use of broadcasting and correspondence media as the major element in the system clearly allows economies of large-scale operation to be exploited. Because of the conceptual and statistical problems involved the paper does not provide any definite conclusions, but suggests that in a period of increasing pressure on resources in higher education, the application of the Open University teaching methods to conventional universities should be studied.

In his comments, Carter,[1] while agreeing entirely with the main conclusions about the cost advantage of the Open University, considers that the comparisons have been quite unnecessarily slanted in favour of the Open University. Carter's own rough calculations suggest the recurrent cost per student to be about 55 per cent that of the conventional university. In addition, Carter argues that the output of the Open University is different to that of conventional universities.

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[1] *Higher Education*, Vol. 2, No. 1, February 1973.

In his reply, while accepting some points, Wagner[1] submits that the statistical significance of some of the amendments is not as great as claimed, and that there are assumptions in favour of conventional universities which might equally be challenged. Wagner emphasizes that the purpose of the comparison is to understand more fully the cost implications of the new system.

Origin

U.S.S.R.

Authors

Kritchevsky, I. A.; Ivanov, A. V.

Title

Comparative Technico-economic Analysis of the Production of Cinema and Television Films in Film Studios. In: *Tekhnika Kino i Televidenia*, No. 6, June 1973, p. 62–5. (In Russian.)

Subject analysis

This article is an account of a study carried out in 1970–71 by the Iprokino Institute. Its purpose was to make a technico-economic comparison of the production factors governing cinema and television films. The article reports on the results.

Contents analysis

At the present time, the Mosfilm, Lenfilm and A. P. Dovjenko studios supply roughly 50 per cent of the annual production of feature films and up to 60 per cent of television films. It is universally acknowledged nowadays that the production of television films in television studios should be extended, since this would enable more efficient use to be made of the technical production facilities of film studios as well as of creative resources.

According to calculations made by the Iprokino Institute, the total showing time of television films that could be produced annually, using 1970 film production techniques, was eighty-five hours; the corresponding figure, using the techniques of 1975—and provided that the investment programme is carried out as planned—would be 130 hours. The results of an analysis of the production factors for television and cinema films show that the basic economic production factors for television films are fundamentally different from those for cinema films. What are the main differences?

First, the useful footage of television films in the three film studios, both for the director's scenario and the shooting script, is 20 per cent lower than for cinema films.

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[1] *Higher Education*, Vol. 2, No. 1, February 1973.

Second, the proportion of exterior shots is high in television films and, in certain film studios, higher than that for cinema films.

The cost price coefficients for cinema and television films show that there is a direct relationship between the productivity of the shooting team and the production time (Table 5).

A reduction in cost price depends chiefly on an increase in productivity of the shooting teams. The lowest cost prices correspond to the highest output rate in a calendar month and the shortest production time, and vice versa.

At current selling prices (and given present-day financial restrictions) the production of television films by film studios is as economically profitable as the production of films for the cinema.

In our view, the basic reason for the lower costs of television films in relation to cinema films is the strict budgetary limits set on the former and the obligation imposed on studios and shooting teams to make a significant increase in output and to work with a minimum of technical and scenic means.

To conclude, the analysis of the production of television films in film studios shows that the manpower and cost requirements, together with the squeeze on technical production facilities for television films, are characterized (in relation to the same factors for a cinema film) by a mean value of 0.4.

This coefficient is obtained by different means in different studios. The experimental study of these two types of film production and the application of the results to all film studios reveal the existence of considerable 'reserves' for increasing shooting productivity and lowering the cost price of television films.

Origin

Canada.

Author

KNOEPFLI, Heather E.

Title

A Cost Analysis Study, Arts 100: Communications.

Bibliographical description

Toronto, The Ontario Educational Communications Authority, 1973. 41 p.

Subject analysis

During the 1971/72 session, the University of Waterloo, in co-operation with the Ontario Educational Communications Authority (OECA), conducted a media-based credit course entitled 'Arts 100, Communications—a Course on the New Literacy'.

The course involved thirty weekly half-hour television broadcasts, a textbook, twelve audiotape cassettes, notes on the audio- and videotapes, monthly small group seminar meetings, and a toll-free telephone line between students and course instructors. The involvement of the two organizations was complementary. The OECA produced the videotapes for the course; the University of Waterloo conducted the course.

Contents analysis

The primary purpose of this report was to delve into the cost of a media-based university credit course as opposed to the cost of a traditional university course.

A secondary purpose of the study was to develop a 'methodology' for conducting cost analysis of media-based courses. This methodology incorporated both indirect or administrative overhead costs as well as direct costs.

The specific objectives of the study were as follows:

To identify and allocate the various elements of cost involved in the developmental and operational stages of Arts 100.

To determine the cost per student.

To determine the on-going costs of Arts 100 and to develop an amortization programme to amortize the development costs.

To identify and allocate the various elements of costs involved in a traditional university course.

To set out a cost comparison between an Arts 100 type of course and a traditional university course.

In summary, annual production costs for a media-based course may range from $60,000 to $120,000. Annual on-going costs will be approximately $70,000.

The annual cost per student may range from $260 to $388, depending on the percentage basis used to assess the general public benefit. The total cost per student for each traditional Faculty of Arts two-term course is $322. This result represents the 'average' cost per student for an undergraduate arts course, all levels being considered. The cost per student, however, will depend on the size of the class (during 1970/71 the average size was 32.2).

A media-based course appears to be more economical than a traditional university course when a large number of students is involved.

A media-based course has a high development or production cost but a low variable or on-going cost; the cost of adding incremental students is relatively low. If relatively few students are involved, however, the traditional university course may be the more economical.

Origin

Federal Republic of Germany.

Authors

DOHMEN, Günther; SCHNEIDER, Walter; SIGELEN, Hermann.

Title

Zur Ökonomie des Fernstudiums.

87

Bibliographical description

Tübingen, Deutsches Institut für Fernstudien an der Universität Tübingen, 1973. 176 p.

Subject analysis

The economics of correspondence courses: an analysis of costs and expenditures in connexion with multi-media correspondence courses as compared with those for conventional university studies.

Contents analysis

The first section of the work indicates the purpose, formal structure and elementary costs of a planning and decision model for the economic evaluation of correspondence study systems. In the second section the authors itemize the costs of correspondence courses and give the initial results produced by the evaluation model. A comparison of the results based on nine examples of correspondence study systems with the results for a single example of conventional university studies suggests that multi-media correspondence courses might be as effective as university studies at one-third of the cost. The third part of the work is an attempt to make a projection of the estimated expenditure on multi-media correspondence courses over a twelve-year period, i.e. from 1973 to 1984. Tables showing costs and expenses.

The purpose of the analysis is to determine the effective cost of studies by correspondence, the circumstances in which correspondence courses might be cheaper than conventional university studies, the principal repercussions of the costs on correspondence courses, the results of changes in structure, organization, teaching methods and techniques, and the economics of a multi-media correspondence course system. In their inquiry into costs and expenses, the authors consider two main elements: the production and presentation of television courses. The first element includes the intellectual and technical preparation, reproduction and equipment; the second, the broadcasting of the course and feedback in the form of examinations and tests.

These cost elements are further subdivided and defined. With regard to the formal construction of the model for making estimates of multi-media correspondence courses, the authors consider first the effects of the costs, then classify the various costs according to their effects and calculate the costs per participant, term and course. Lastly, these costs are integrated in the aggregate cost of a study system. The interrelationship of individual effects is interpreted through the use of mathematical formulae.

In the second section, Hermann Sigelen indicates the costs of correspondence courses on the basis of the initial results produced by the model. These costs are estimated for nine possible examples over the 1970–85 period. These estimates are based on a constant number of students, students per course, different courses, courses completed on average by a student per term, on invariable intellectual production costs and different media in varying proportions, on variable localities and methods of study and on the number of tests and courses to be revised and modified after five, ten or twenty terms. The results of these calculations show that the most expensive example costs over nine times more than the cheapest. A further result is that costs fall most steeply when a large number of persons participate in courses each term (more than 200 and preferably more than 5,000), when the courses can be used for a prolonged period (more than five years and preferably ten years or more) without major revision, when the use of audio-visual means is kept to a minimum and when there are two direct stages with course supervisors.

In the third section, Hermann Sigelen, Uwe Brande and Ingrid Möller attempt to calculate expenditure on the intellectual production of courses from 1973 to 1984. Calculations are made for six variants, i.e. for two productivity variants combined with three different numbers of courses which would be available after twelve years.

Origin
Federal Republic of Germany.
Author
SCHIRM, Rolf W.
Title
Über die Entwicklung der Kosten für die Software Audiovisueller Systeme [The development of Costs for the Software of Audio-visual Systems]. In: A. O. Schorb (ed.), *Visodata 73; Mediensysteme im Bildungswesen; 1. Konferenz mit Sonderschau, München, 15–17 Januar 1973*, p. 307–14.
Bibliographical description
Munich, Munich Fair, 1974.
Subject analysis
The need to invest in software in order to make rational and effective use of audio-visual equipment in education.
Contents analysis
It has been observed that much of the equipment employed in the new educational technologies is rapidly superseded, under-used or even abandoned. There are two main reasons for this. First, there is too great a discrepancy between the technical potential of the equipment on the one hand and teaching requirements on the other; often the equipment available is highly ingenious but ill-suited to teaching problems. Second, there is a bottle-neck in regard to software. Potentially or theoretically effective equipment is under-used, badly used or not used at all owing to the lack of suitable software.

Many manufacturers deliver equipment with the advice that the users should produce their own software. This practice is not very sensible, since it obliges hundreds, if not thousands, of users to duplicate each other's work, which leads to considerable wastage. Furthermore, the proper use of such equipment requires professional training which the teachers to whom it is entrusted have usually not received. Often it proves necessary to form teams composed not only of teachers but of the full range of audio-visual professionals.

Software is important at three different levels. First, the analysis of educational objectives: what is to be taught? Second, the analysis of the target audience: who is to be taught? Third, continuous analysis of the performance of the technology and equipment employed, from the design stage (tests, evaluation).

If these requirements are taken into account, the author estimates that the cost of software for one minute of audio-visual teaching lies between DM.2,000 and DM.4,000 (the estimate of DM.4,000 is more likely if recourse is had to private firms).

For a target group of 400 pupils, the cost is therefore prohibitive; for 4,000 it is expensive; for 40,000 it is just tolerable; and for 400,000 it becomes highly competitive.

It is therefore important to make a precise estimate of the target audience before undertaking a programme of this kind, for it very often happens in European countries that the number of pupils is insufficient.

Origin
United States.
Author
SCHRAMM, Wilbur.
Title
ITV in American Samoa—after Nine Years. In: *Information Bulletin.*
Bibliographical description
Washington, DC 20036, Information Center on Instructional Technology, Academy for Educational Development, 1424 16th Street N.W., March 1973. 55 p.
Subject analysis
This is the first report on the ITV project in American Samoa in which it has been possible to base conclusions on any considerable amount of hard data. The new data include:

(a) Three years of standardized achievement testing in the American Samoa high schools, two years in the elementary schools.
(b) A number of locally made and criterion-referenced tests.
(c) Several small experiments on language arts and mathematics.
(d) Standardized tests of English-language proficiency.
(e) A new study of schoolchildren on the one island in American Samoa that has never had television, in an attempt to estimate the extent of change since the project began.
(f) An attitude survey of teachers and students.
(g) A new cost study.

(h) Some experimental comparisons, not yet complete, of the language strategies of the two Samoas.

There have been two studies of the cost of ITV in American Samoa, by Vaizey in 1966 and by the present writer in 1973.

Contents analysis

The input: how much ITV costs. In nine years, the capital investment in Samoa ITV has been about $2.75 million, and the cumulative current costs, exclusive of capital replacement and interest, have apparently been between $10 and $11 million.

Vaizey, in 1966, estimated the current costs of television, at that time, as $1.423 million, including capital depreciation and notional interest. Per pupil cost for each of the 6,600 students in the public schools at that time would be $216, or about 59 cents per student-hour of ITV.

In early 1973, we calculated the annual current cost of ITV, including capital depreciation and notional interest, at $1.275 million, or $157 for each of the 8,100 pupils (see page 10 for detailed figures on annual costs of ITV and the two other television services).

Why should 1973 unit costs, despite inflation, be lower than costs for 1966? For one thing, the adult service in particular, and the Early Education programme to a lesser degree, have developed greatly in the intervening years, and therefore should absorb larger proportions of general television cost than before.

American Samoa has a television installation that could serve many more schools and pupils than it does. It could easily serve ten or twenty times as many. If the school audience were multiplied by ten, Vaizey figured that the unit cost would be approximately one-fifth the 1966 cost, and the present writer estimated that the 1973 cost of $157 per pupil could be reduced to between $25 and $30.

It is probable that the architects of the American Samoa plan, in the expansiveness of the early 1960s, anticipated the extension of the television service beyond Samoa.

The figure of $157 per pupil per year is more than the total per-student cost of education for most countries of the world, indeed, more than the average *per capita* income for many of them. Therefore, the Samoa example would have to be considered very carefully by the economists of any developing country that thought of imitating it.

Amongst the administrative and strategic aspects of the Samoa project is the decision to begin by serving all the primary grades in the first year and all high school in the second year, rather than introducing the new system one year or two years at a time. A significant part of the administrative history of the project is the accomplishment of turning the system almost completely over to the Samoans in nine years.

It began as an imported project, planned and operated by mainlanders, just as Niger started as an imported French project.

Of all the chapters in the administrative history of Samoa's ITV, perhaps the most interesting one to future historians will be the story of the return of leadership to Samoans.

It has usually been concluded that if a large ITV or educational reform project is to have a real impact on a developing country, it is better, even at the cost of some quality and some efficiency, to place it from the start completely under the control of the host country.

Origin
United Kingdom.
Authors
LAIDLAW, B.; LAYARD, R.
Title
Traditional Versus Open University Teaching Methods: a Cost Comparison. In: *Higher Education*, Vol. 3, No. 4, November 1974, p. 439–68.
Subject analysis
Fixed and variable costs per student of the Open University (OU) and campus universities. Use of OU packages in campus universities. Expansion and development of OU courses. Economies of scale. Printing costs.
Contents analysis
The paper attempts to throw light on the relative costs of OU teaching methods only, and not to evaluate the OU as such.

Part I describes the OU teaching system, and the OU budget is broken down into fifteen components. Part II analyses each budget component to determine if the cost is fixed or variable with respect to student numbers. The fixed and variables costs for twenty-six OU courses are tabulated.

Part III computes fixed and variable costs for similar courses at campus universities, and determines the break-even number of students before the OU becomes cheaper. For example, in one foundation course (where S is student numbers):

$$£162{,}558 + 56.S = £401 + 117.S$$

where the left-hand side is OU costs, and the right-hand side campus university costs (£). The high fixed and low variable OU costs show economies of scale.

In all courses but one, the variable cost per student is substantially lower in the OU. This constitutes a strong case for the use of OU packages in campus universities. It also constitutes a case for expansion of existing courses at the OU.

As regards the development of new OU packages, the paper shows the foundation courses to be much cheaper than equivalent provision *de novo* at the same scale in campus universities. Measured by the break-even number of students, second-level courses in a given faculty are cheaper than foundation-level courses. But they also have fewer students and some are operating at levels which, if there were no interdependence between courses, might be considered expensive. For higher level courses with even fewer students, it may be possible to switch from high fixed-cost components such as broadcasting to instruction whose cost is largely variable, for example various forms of face-to-face teaching.

The paper does not cost student time, but if this is cheaper when OU teaching methods are used, this is a further argument in their favour.

An annex to the paper considers OU printing costs, and economies of scale with respect to number of copies.

Case studies

Radio

Mexico's Radioprimaria[1]

Mexico, along with many other developing nations, faces a contradiction in the provision of basic education for its population; there is the desire, expressed in popular feeling and even in legislation, to provide a complete primary-school education for all, while at the same time there are not even enough teachers, classrooms and materials, especially in the rural areas, to support the school-age population. Of the 32,855 primary schools in the country, only 6,440 have a full six-grades complement, with most of them located in urban areas.[2]

In an attempt to cope with this problem, the Mexican Secretariat for Public Education (SEP) initiated in 1969 an experimental programme that utilized instructional radio to help provide fourth-, fifth- and sixth-grade education to certain rural and semi-rural regions lacking a complete primary school. In considering Radioprimaria, the main emphasis will be on the costs of the system: the first section will describe the system in general, its technical characteristics, organization and utilization, as well as briefly summarizing evidence as to its effectiveness; the second section will analyse the costs of the system in detail; the third section will compare the costs of Radioprimaria with those of the traditional direct teaching system; and the fourth section will present some conclusions. The discussion in the first section is based on an analysis of the structure and utility of Radioprimaria by Spain[1] and the interested reader is referred to that analysis for additional details; subsequent sections are the work of the authors (a somewhat less-detailed cost analysis by one of the authors is included in Spain).[1]

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[1] Extract from Dean T. Jamison, Steven J. Klees and Stuart J. Wells, *Cost Analysis for Educational Planning and Evaluation: Methodology and Application to Instructional Technology*, Part Three (draft version), Princeton, N.J., Economics and Educational Planning Group, Educational Testing Service, 1975.

[2] See S. Klees, *Education in Mexico: the Primary and Secondary School System*, Stanford University, 1972. (Unpublished paper.)

The system

Organization and technical characteristics

Planning for the Radioprimaria system began in 1969. During the 1969/70 school year, the system was utilized in twenty-nine schools in the Valley of Mexico and the Federal District, but was not continued in this region after the first year, except for one classroom in the Experimental Education Centre in Mexico City. At the beginning of the 1970/71 school year, the system was tried out on a small scale in the State of San Luis Potosí and is still in use there at the time of writing. This case study represents an analysis of Radioprimaria as instituted in San Luis Potosí.

Radioprimaria was intended primarily to allow a school with four teachers to offer all six grades of primary schooling. Three teachers would handle the first three grades in the traditional manner; the fourth teacher would have the fourth, fifth and sixth grades in one classroom and would teach with the assistance of radio lessons. Some instructional radio programmes would be grade-specific while others would be directed to all three grades in common. When grade-specific lessons are broadcast, the students in the other two grades are supposed to engage in work on their own. It should also be noted that the above structure implies that students may be directed to listen to the same common broadcasts each year for three years.

Instructional radio lessons are prepared by a team of eight radio teachers in studios located in Mexico City. The recordings are shipped by bus to San Luis Potosí, where they are broadcast by the University of San Luis Potosí radio station (at no charge to SEP) within a thirty-mile radius around the capital city. Broadcasts are made every school day, Monday to Friday, from 9 a.m. until 12.45 p.m. In Mexico City, the programmes are broadcast one hour earlier over Station XEEP, in order to be utilized by the experimental classroom, as well as by some traditional primary schools using the lessons on an informal basis.

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[1] See P. Spain, *A Report on the System of Radioprimaria in the State of San Luis Potosí, Mexico*, Stanford University, Institute for Communication Research, 1973.

Each radio lesson lasts fourteen minutes and about five programmes are broadcast each school day. The subjects of the broadcast are taken from the official primary-school curriculum and are keyed directly to the required textbooks. Emphasis is placed on Spanish, arithmetic, history and geography, although lessons dealing with physical education, nature study, and practical activities are common. Classroom teachers receive every other week a mimeographed document containing the radio-lesson schedule and suggested activities to complement the broadcast.

Utilization

In 1972, there were forty-three schools serving about 2,800 fourth-, fifth-, and sixth-grade students utilizing the radio lessons. However, contrary to the original plan, only seven of these schools instead of a possible seventy in the state were incomplete schools offering less than six grades of primary school. Moreover, about 60 per cent of the schools with all six grades did not have six teachers, so that very often two or three of the higher grades had already been combined into one classroom with one teacher.

There is no reliable information on the number of students participating in the system in the first year of its operation in San Luis Potosí. Furthermore, it is known that the Mexico City broadcasts are picked up and utilized by schools that do not formally participate in the Radioprimaria programme, but again, no data are available on the extent of such use. Since, moreover, the broadcasts are open circuit, over normal radio band frequencies, in both San Luis Potosí and Mexico City, it is thought that there are many adults who tune in to the lessons. Indeed, one of the original goals of the Radioprimaria system was to allow adults who had not completed primary school to participate as informal students. However, this goal has not been pursued to date.

Over the school year, about 1,200 fourteen-minute programmes are broadcast, representing approximately 280 hours. Given that about 80 per cent of the programmes are directed to the combined fourth-, fifth-, and sixth-grade audience, with the remaining 20 per cent distributed among the three, the average number of hours directed at students in any particular grade may be estimated at 242 per year.

Effectiveness

Spain gave pre-tests and post-tests over a semester period to a random sample of radio and non-radio students in the sixth grade. He concludes from the test results that Radioprimaria 'has produced scores that are comparable to those of the children in direct teaching schools'.[1] However, there are some doubts as to the reliability of the results generated, which Spain himself explicity recognizes. For example, although the rural radio classes had higher gain scores than the non-radio classes,[1] only a few of the radio classes are of the type for which the Radioprimaria system was originally intended. The gain scores in arithmetic of those radio classes that have newly instituted sixth grades were significantly lower than those of the non-radio schools (Spanish scores were still higher); however, this comparison is still somewhat confused, in the absence of separate gain score figures for the non-radio classes that had one grade to a classroom and for those that combined three grades in one classroom. The problem is even more complex because, while some radio and non-radio schools combine fourth and fifth grades, others combine fifth and sixth, and still others combine all three. We therefore concur with Spain in emphasizing that 'a more controlled and genuinely experimental assessment of the Radioprimaria system' is still needed.[2]

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[1] Spain, op. cit., p. 42.

In many respects, Spain's evaluation of some of the other aspects of the Radioprimaria system is more enlightening than the analysis of cognitive outcomes described above. By visiting all the radio schools and several of the non-radio schools, and by talking with system participants, a number of problems were uncovered. Spain estimates that 15–20 per cent of the classes miss the first half-hour of broadcasts owing to the late arrival of teachers and/or students. Furthermore, of the forty-four radio schools visited, one was inexplicably closed and eighteen others were not using the radio that particular day—either because it needed repair, or because of a power failure, or because the teacher had decided the lessons were not useful.

No federal funds are allocated for the purchase of radios and consequently they must be bought and maintained by the teacher or the community; in one case, no radio had been purchased because the teacher and the community could not agree on who would pay for it. Of the remaining twenty-five schools found using radios, seven had inaudible receivers. Spain reports widespread reception problems, which is not surprising given the funding arrangements which do not seem conducive to the purchase and maintenance of adequate receivers.

Spain attributes many of the above problems to the inadequacy of resources allocated for school supervision. Schools have been dropping out of the Radioprimaria system; in the first year of operation there were forty-nine radio schools, in 1971/72 there were forty-four, and the following year there were only thirty-seven. Spain describes how initial acceptance of Radioprimaria was encouraged by the Director of the local Audiovisual Centre, through frequent visits to the rural classrooms. However, his automobile broke down at the end of the first year and no resources were forthcoming from the federal government to support such efforts in subsequent years. Consequently, Spain feels that enthusiasm for the system has been waning.

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[1] Spain, op. cit., Table 7.
[2] ibid., p. 44.

Finally, Spain examines the potential benefits of Radioprimaria's extension of primary-school education in rural areas. Contrary to the avowed government intention that the system should aid rural development, parents and students see primary-school graduation primarily as a way of quitting the rural areas and competing in the urban labour market. Even more unfortunately, Spain's assessment of the employment market in the chief urban area of the state, the capital, indicates widespread unemployment and a surplus of primary-school graduates.

TABLE 7. Costs of Radioprimaria in 1972 United States dollars[1]

Interest rate (%)	0		7·5		15	
	Fixed	Variable	Fixed	Variable	Fixed	Variable
	Student	Hour	Student	Hour	Student	Hour
Production						
Capital						
Studios		1.43		2.80		4·57
Studio equipment		2.96		5.81		9·49
Audiotapes		0.34		0.67		1.09
Recurrent						
Personnel		100.00		100.00		100.00
Equipment maintenance		5·93		5·93		5·93
Transmission						
Operations		14·43		14·43		14·43
Reception						
Capital						
Receivers	0.09		0.11		0.13	
Recurrent						
Operations and maintenance	0.04		0.04		0.04	
TOTAL	0.13	125.09	0.15	129.64	0.17	135.51

[1] Cost data were gathered by Klees in 1972. Production and transmission costs are assumed to vary with the number of hours broadcast per year, which was 280 in 1972. Reception costs are assumed to vary with the number of students in the system, which was 2,800 in 1972. The basis for each cost component estimation is as follows:

Studios. The two studios and one control room cost approximately $8,000 to construct. This is annualized over an assumed twenty-year life.

Studio equipment. The studio equipment cost $16,600 and is annualized over an assumed ten-year life.

Audiotapes. Audiotapes cost $6.80 for a tape of high quality; 280 such tapes are needed and their cost is annualized over an assumed ten-year life.

Production personnel. The salaries of administrators, technical personnel and radio teachers totalled $28,000 in 1972.

Production-equipment maintenance. This cost is assumed to be 10 per cent of the value of the studio equipment, or $1,660 per year.

Transmission operations. A cost of $14.43 per hour of transmission was estimated by the University of San Luis Potosí radio station for use of its 250-watt transmitter and broadcast facility.

Reception receivers. Radio receivers are assumed to cost $20 and are annualized over an assumed five-year life. The average class size is assumed to be forty-five, which although somewhat higher than usual for rural areas in Mexico, reflects the use of combined grades in one classroom.

Reception operations and maintenance. This cost is assumed to equal 10 per cent of the cost of a receiver annually.

Costs of the system

Table 7 shows the costs of the Radioprimaria system in a form that assumes a linear variation of total costs with the number of students in the system and the number of hours of radio lessons broadcast annually. That is,

$$TC\,(N, h) = F + V_N N + V_h h,$$

where: TC = total cost; N = the number of students the system serves; h = the number of hours the system broadcasts; F = fixed cost of the system; V_N = costs of the system variable with N; V_h = costs of the system variable with h.

It should be stressed that the cost-function parameters presented are only approximations; cost data were available for only one year (1972), and to apply the cost function that will be summarized below to rates of utilization different from those existing in 1972 requires some rather definite assumptions. First, it will be noted that there are no fixed costs of the system; all costs are assumed to be variable with N and h. As regards production costs, this assumption is obviously not true for marginal charges in the number of hours broadcast, since, for example, sufficient personnel, studio space and studio equipment probably already exist for production to be somewhat expanded. None the less, taking a longer view, all these cost components vary to some degree with the number of broadcast hours produced. It should be noted that a smooth linear function as posited is only a rough approximation to what is probably a step function—that is, investments in production are 'lumpy' in that a certain amount must be invested regardless of the extent of production and that another lump investment would be needed for expansion when there is no excess capacity left in the initial structure.

It might be thought that the transmission components would have significant fixed costs, but this will only be the case when transmission facilities are constructed, as opposed to leased or donated. In the latter case, a cost is charged or imputed on an hourly basis that includes an allowance for capital amortization. Finally, reception costs, which include radio receivers and their maintenance and operation, may be reasonably assumed to vary directly with the number of students in the system; this assumes that class size would not be increased, although for marginal expansion this is always a possibility.

Table 7, based on the cost information indicated in the accompanying footnote, calculates Radioprimaria costs for each of three social rates of discount, 0 per cent, 7.5 per cent and 15 per cent. Production costs equal $110.66 per hour given no discounting for the future; $115.21 per hour at a 7.5 per cent rate; and $121.08 per hour at a 15 per cent rate. Although transmission costs should also vary with the discount rate, the $14.43 per hour figure was obtained from personnel at the University of San Luis Potosí radio station without sufficient itemization

TABLE 8. Cost function and average cost, 1972

	Total cost equation	AC_N	AC_N/V_N	Cost per student-hour
$r = 0\%$	$TC = 0.13\,N + 125.09\,h$	12.67	84.33	0.052
$r = 7.5\%$	$TC = 0.15\,N + 129.64\,h$	13.12	77.24	0.054
$r = 15\%$	$TC = 0.17\,N + 135.51\,h$	13.72	72.32	0.057

to allow separation of capital and recurrent costs. Finally, reception costs are \$0.13 per student at a 0 per cent discount rate; \$0.15 per student at a 7.5 per cent rate; and \$0.17 per student at a 15 per cent rate.

The cost function and average cost information for 1972 is summarized in Table 8.

The average cost per student (AC_N) assumes Radioprimaria utilization levels of the year 1972: 2,800 students and 280 hours broadcast. The cost per student-hour figure reflects an unusual feature of the Radioprimaria system; that is, students receive about 242 hours of instructional radio each year, although only 280 hours are produced in total for all three grades, since 80 per cent of the broadcasts are aimed at the combined three-grades audience. The ratio of average cost per student to variable cost per student indicates that production costs dominate system costs, not surprisingly in view of the tentative, experimental nature of the system at this date. Average costs per student could be lowered substantially by expanding to include more students in the system. Finally, costs are sensitive to the interest rate; Radioprimaria costs almost 10 per cent more if in respect of the future we adopt a 15 per cent interest rate than it would if we neglected to take time preference into account.

Comparison of costs with those of the traditional system

Radioprimaria was conceived, in part, as a less expensive method than the traditional direct-teaching system for providing a full six grades of primary school in rural areas. Table 9 examines this under somewhat hypothetical conditions. It is assumed that the choice facing the SEP is whether to take students in a rural area and give them fourth-, fifth- and sixth-grade education in three classrooms with three teachers, or to put them in one classroom with one teacher and one radio for three years.

Even if enough teachers could be found who were willing to work in rural communities (a problem in Mexico), Table 9 indicates that the Radioprimaria alternative is much less expensive than the traditional system; the former costs about 60 per cent less than the latter and this advantage would be increased if student utilization were hypothesized to be greater than 2,800. The additional costs of the instructional-radio components of the Radioprimaria system are more than offset by the reduced teacher and facility costs resulting from the combination of three grades into one classroom with one teacher.

TABLE 9. Radioprimaria *V.* traditional instruction: annual cost per student, in 1972 United States dollars[1]

	Radioprimaria	Traditional instruction
Traditional components		
Administration	50	50
Classroom teacher	32	96
Facilities	6.10	18.29
SUB-TOTAL	88.10	164.29
Instructional-radio components		
Production	11.53	0.00
Transmission	1.44	0.00
Reception	0.15	0.00
SUB-TOTAL	13.12	0.00
TOTAL ANNUAL COST PER STUDENT	101.22	164.29

[1] This cost estimate assumes an average of fifteen students per grade, which would yield a forty-five student class size for the Radioprimaria system. A social discount rate of 7.5 per cent is used for capital amortization. The assumption on which each component is based is as follows:

Administration. This is a very rough approximation, equal to the administrative cost per student calculated for the traditional secondary-school system.

Classroom teacher. This assumes that the salary of a primary-school teacher is equal to the average for such teachers in Mexico in 1972, which was $1,440 per year.

Facilities. This assumes that the cost of a fully equipped rural classroom is $2,800 and has a life of twenty years. This figure is half that given in an untitled SEP report which estimates the cost of an urban classroom; the halving of this estimate reflects the lower-cost classrooms that are usually constructed in rural regions in Mexico.

Instructional-radio components. These figures follow from those given in Table 7, assuming a 2,800 student enrolment as in 1972.

Discussion

The Radioprimaria system is an interesting attempt to meet the problem of insufficient educational opportunities in rural areas which faces Mexico and most other developing nations. Although its costs may appear somewhat higher than other instructional-radio projects, this is entirely due to its present experimental, low student-utilization format; if the number of students included in the system expanded, costs per student could fall substantially. Furthermore, as noted in the previous section, the unique configuration of the system, which combines several grades in one classroom with one teacher, results in considerable cost savings over the traditional direct-teaching system. Of course, despite a favourable cost comparison, the merits of the system must be judged by cost data combined with information on relative pedagogical effects and long-run benefits.

In terms of pedagogical effects, Spain's analysis appears inconclusive, since there was no clear comparison of joint fourth-, fifth-, and sixth-grade classrooms with radio, versus direct teaching with one teacher assigned to each grade. Spain[1] does indicate that there may be some problem with the grade-specific instructional-radio lesson format utilized in Radioprimaria, in that the students not receiving the broadcasts 'did not show a great deal of concentration' when they were supposed to be working on their own. This is not especially surprising since the on-going radio lesson would doubtless be distracting. In addition, it is at least questionable on *a priori* grounds whether common fourth-, fifth-, and sixth-grade broadcasts, which are likely to be repeated to a student each year for three years, are a beneficial pedagogical tool. In short, before adopting such a system as Radioprimaria in another country, or expanding the system in Mexico, it would seem wise, as Spain suggests, to engage in a more rigorous effectiveness comparison.

Finally, it should again be emphasized that the individual and societal benefits of increasing primary-school enrolment in rural areas are at least questionable according to Spain's analysis. Although this does not reflect on Radioprimaria, *per se*, as compared to alternative instructional techniques, instructional-technology systems are being utilized more and more frequently to extend educational opportunities to rural areas, to meet social demands and consequent political obligations. Careful attention must be given to the question of whether this social demand is based on reliable information, or whether additional education merely increases the rural exodus to overcrowded urban areas that lack sufficient employment opportunities. Increasing the educational opportunities in rural areas should involve more than the straight transfer of an urban curriculum; increased consideration needs to be given to real rural development and its meaning for education, in order to allow the promise of educational benefits to become a reality.

Instructional radio in Nepal[2]

The system

The purpose of this chapter is to report highly tentative cost estimates for instructional radio in Nepal. The estimates are tentative for two reasons. First, although new studios for instructional radio have recently been completed and equipped, the existing in-school programmes are conducted only on a pilot basis with no commitment on the part of the government to operational implementation. There is thus not even a planned system configuration upon which to base cost calculations. Second, such cost data as are available are less-adequately based than for most of the other case studies. None the less, the information available on Nepal is included because relatively little cost information exists for instructional-radio systems, and because the construction, equipment and personnel requirements for the new instructional-radio production facility may prove a useful guide to others.

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[1] Spain, op. cit., p. 35.
[2] Extract from Jamison *et al.*, op. cit.

Mayo, Herm, Hornik, Jamison, Sahter, and Smee[1] provide a thorough overview of existing uses of radio in Nepal for formal and non-formal education, and outline a number of possibilities for its further development. Readers are referred to that document for further information on instructional radio in Nepal.

The discussion of cost concentrates on transmission and programme-production costs. Reception costs are only briefly dealt with because, in the case of non-formal education, radios were used for such a small pilot project that computation of the (extremely high) reception costs per hour would be meaningless. Transmission costs are discussed first, then production costs for school broadcasts, then production costs for non-formal broadcasts. Finally, reception costs are considered. There is no discussion of costs per student because the project remains in a pilot phase with limited commitment for its widespread implementation.

Transmission costs

Table 10 summarizes the cost of Radio Nepal's transmission system. Costs in this table should be regarded as approximate only, and in some cases are based on an estimated division of costs between Radio Nepal's transmission and production operations.

Capital and land costs have been annualized using standard accounting procedures; these annualized costs are $102,379 per year. To this must be added recurrent costs of $133,350 per year for a total annual cost of $235,729 per year. As Radio Nepal broadcasts for about eighty-five hours per week (4,420 hours per year) the average cost per hour of transmission is $53.33.

Production costs

In this subsection, the principal concern is with the cost of producing school broadcasts. In addition, however, estimates are available for

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[1] J. R. Mayo *et al.*, *Development of Radio for Nepal: Report of the Radio Feasibility Study Team; a Report Prepared for the British Council, UNICEF and USAID*, February 1975.

TABLE 10. Transmission costs of Radio Nepal in 1975 United States dollars

	Annual cost	Capital cost	Annualized cost[1]
Capital cost			
Transmitters (ten-year lifetime)		414,750	60,553
Khumaltar site			
Building (fifty-year lifetime)		84,000	6,468
Land (unlimited lifetime)		245,700	18,427
Jawalakhel site (value for building and land)[2]		84,000	6,384
Main headquarters in Kathmandu (half of headquarters costs are attributed to transmission)			
Land (unlimited lifetime)		57,750	4,431
Buildings and miscellaneous (fifty-year lifetime)		39,622	3,050
Generators (ten-year lifetime)		21,000	3,066
TOTAL ANNUALIZED CAPITAL COSTS			102,379
Recurrent costs			
Electricity and gas for generators	23,100		
Maintenance and spares	89,250		
Personnel salaries (assuming that 20 per cent of permanent staff of Radio Nepal are involved with transmission)	21,000		
TOTAL ANNUAL RECURRENT COSTS	133,350		
TOTAL ANNUAL COSTS	235,729		

Usage of system
Number of hours of use per year
(52 weeks × 85 hours per week = 4,420 hours)
Cost per average hour of transmission = $53.33

1. Capital costs are annualized using standard accounting formulas; a 7.5 per cent interest rate is used as an estimate of the costs of capital.
2. Annualized under assumption that half the value is land.

Source: Interview with K. B. Khatri, Acting Director-General of Radio Nepal, 18 November 1974.

the cost of producing several non-formal education series, and these are included here for purposes of comparison.

School broadcasts

The production of the present series of school broadcasts (one twenty-minute broadcast per week in fourth-grade social studies plus teacher education) takes place at the Janak Educational Materials Organization (JEMO) just outside Kathmandu. JEMO has recently completed the installation of a new studio, and the capital costs presented here are based on expenditures for that studio. Table 11 summarizes the production costs for school broadcasting. From it will be seen that the fixed costs are equal to the cost of staff ($10,500 per year) plus the annualized cost

TABLE 11. Radio production costs at JEMO in United States dollars

	Annual cost	Capital cost	Annualized cost[1]
Capital costs[2]			
Reconstruction of shell to house studio (fifty-year lifetime)		26,250	2,021
Ventilation and air-conditioning (twenty-year lifetime)		7,350	720
Acoustic treatment and installation (twenty-year lifetime)		8,400	823
Studio equipment (ten-year lifetime)		15,750	2,299
TOTAL ANNUALIZED CAPITAL COSTS			5,863
Recurrent costs			
Basic production staff of fourteen persons	10,500		
Direct costs per twenty-minute programme assuming eleven programmes per week for twenty-six weeks per year[3]	9,765		
TOTAL ANNUAL RECURRENT COSTS	20,265		
TOTAL ANNUAL COSTS[4]	26,128		

1. Capital costs are annualized using standard accounting formulas; a 7.5 per cent interest rate is used as an estimate of the costs of capital.
2. Annualization based on a fifteen-year studio lifetime.
3. Cost per programme: tape $10.50; script-writing, $7.90; actors, $15.75; total, $34.13. Information on the exact value of these incremental costs is conflicting; in particular, the cost of actors may be somewhat less than is indicated here.
4. While these total annual costs are based on JEMO-planned budgets, there is no explicit provision for a programme library, sound effects, light and electricity, and use of library. Some of these will be provided by existing JEMO resources (e.g. the library); others may entail additional costs.

Source: Interviews at JEMO, 20 November 1974.

of capital ($5,863 per year) for a total of $16,363 per year. To these basic fixed costs must be added variable costs of $34.13 per twenty-minute programme; thus, total annual production costs at the studio become:

Annual production costs = $16,363 + ($34.13 × number of programmes).[1]

In the recent past, the production level was four programmes per week (104 per twenty-six-week year); this yields a total cost of $19,912 per year, or $191.47 per twenty-minute programme. This level of output sharply under-utilized permanent staff and present plans call for expansion of output to eleven programmes per week in 1975, with the same studio and permanent staff. At this rate of output, annual production costs will be $26,128, as indicated in Table 11, and the average cost per twenty-minute programme will be $91.36 or $274 per production hour—slightly less than half the unit costs resulting from a production level of four programmes per week. Assuming that programmes are

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[1] This formula would fail for a rate of programme production above about fifteen programmes per week.

TABLE 12. Approximate radio production costs of the Agricultural Information Service[1] in United States dollars

	Annual cost	Capital cost	Annualized cost[2]
Capital costs (estimates)			
Two Akai recorders		787	
Microphone		52	
Construction and acoustics		1,050	
Small cassette recorders		158	
TOTAL CAPITAL COSTS[3]		2,048	298
Recurrent costs			
Tape	315		
Personnel (full-time expert at $52.50 per month)	1,890		
Travel	420		
TOTAL RECURRENT COSTS	2,625		
TOTAL ANNUAL COSTS	2,923		

Programme output (four fifteen-minute programmes per week for fifty-two weeks)
Cost per fifteen-minute programme (208 programmes) = $14.05
Cost per hour (fifty-two hours) = $56.21

[1] Cost estimates in this table are highly tentative.
[2] These costs are annualized at a discount rate of 7.5 per cent.
[3] Annualized assuming ten-year life.

used on an average of four years each, the annualized cost per programme hour (at a discount rate of 7.5 per cent) is $82.

Non-formal education

Various agencies wishing to use Radio Nepal for non-formal education do so at present in one of two ways. Either they operate their own studio facilities and simply deliver a completed tape to Radio Nepal for transmission, or they utilize Radio Nepal's studios and personnel to prepare their programmes. Cost estimates are presented here for a programme of each type: the Agricultural Information Service of the Ministry of Agriculture operates its own studio and the Family Planning and Maternal and Child Health Programme of the Ministry of Health uses Radio Nepal studio facilities.[1]

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[1] The purpose here is not to provide a cost analysis of the entire range of information services provided by these two units, but simply to examine the radio component. New Educational Reform Associates' (New ERA) *Radio Listening Patterns in Nepal, 1974* and *Non-Formal Education in Nepal* (October 1974) describe these and other projects in more detail.

TABLE 13. Costs of Family Planning Programme[1] in United States dollars

Payments to Radio Nepal[2]	
Payments for sixty-second spots ($42 for each of thirty per year)	1,260
Payments for fifteen-minute programmes ($13.13 for each of 104 per year)	1,365
In-house expenses	
Salaries (approximate, based on two full-time experts at $63 per month each)	1,512
Travel, tape and other miscellaneous expenses	525
TOTAL	4,662

1. The cost figures are highly tentative.
2. The payments to Radio Nepal include expenditures for writers, composers, musicians, actors and radio technicians. For the spots on the Commercial Service, the $42 includes $2.63 to pay for two airings of the spot.

Agricultural Information Service

The Agricultural Information Service broadcasts four fifteen-minute programmes per week; these programmes are colloquial in style, and are directed to the farmer. New ERA's study of radio listening patterns found this to be the second most popular programme on Radio Nepal.

Table 12 summarizes, very tentatively, the costs of radio production at the Agricultural Information Service. The studio is small and makeshift, resulting in low capital costs (compared, for example, to JEMO, Table 11); recurrent costs therefore dominate. It should be noted that the Agricultural Information Service currently employs about fifteen people and is engaged in a range of tasks in addition to radio production. The attribution of personnel costs to radio is therefore partly guesswork.

As Table 12 indicates, the cost per fifteen-minute programme (assuming 208 programmes per year) is very reasonable: $14.05.

Family Planning and Maternity and Child Health Programme

This programme, which comes under the Ministry of Health, produces two fifteen-minute broadcasts per week (each of which is inserted into another longer broadcast) and, in addition, produces one-minute spots for insertion into the Commercial Service of Radio Nepal. Perhaps two or three new spots are produced each month. (An estimated thirty new spots are produced each year.)

Table 13 tentatively summarizes the costs incurred by the programme. What is perhaps most striking is the relatively high cost of the spots; Radio Nepal receives $42 for producing a one-minute spot, only $13.13 for a fifteen-minute programme. The spots often take an hour of studio time to produce; the programmes seldom take more than half an hour.

If we (arbitrarily) divide the in-house expenses between the spots and the programmes, we find that the spots cost about $78.86 each and the fifteen-minute programmes about $22.11.

Reception costs

We have no information on the actual costs of radio reception in the ongoing experiments with school broadcasting in Nepal; the costs are, however, low since they involve only relatively inexpensive receivers plus their power supplies. In order to get a rough estimate of what radio reception costs for school broadcasts would be, we can turn to two sources on the costs of radio receivers for the general public—New ERA (already mentioned) and Rathjens *et al.*[1]. The typical radio-owner in Nepal paid $67 for his set, which normally includes a short-wave reception capability. Part of the high price results from transportation costs and relatively limited marketing; much of it results from high import duties (70–80 per cent) and a 10 per cent purchase tax. While it might be politically difficult to eliminate the import tax,[2] its value should be excluded from cost analysis of the instructional-radio system since the tax on school radios merely amounts to an internal transfer between departments.

For the purpose of this analysis, we assume that the tax-free cost to Nepal for radio receivers of sufficient quality for school broadcasting will be $50 and that power and maintenance for them will cost $10 per year. If the $50 initial cost is annualized over five years at a 7.5 per cent discount rate, its annualized cost is $12.36; the total annual cost, including power and maintenance, is then $22.36. Assuming an average class size of thirty-five, and one receiver per class, the reception cost per student per year is $0.64.

Cost function

The cost function for school broadcasting in Nepal has only one reliable term—that for variable costs with respect to number of hours broadcast, V_h. V_h is the sum of the costs per hour of transmission ($53) plus the cost of programming which is $82 per hour of programming per year. V_h is, then, $135.

The fixed costs, F, are assumed to be zero; i.e. available information on fixed costs distributes them to programming and transmission costs. Finally, the marginal costs per student, V_N, for which estimates were made in the preceding subsection using hypothetical assumptions, is $0.64. The total cost function is, then:

$$TC(N,h) = \$0.64N + \$135h.$$

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[1] G. Rathjens, R. Butman and R. Vaidya, ***Radio Broadcasting and Telecommunications in Nepal; a Paper Prepared for USAID***, 1975.

[2] Nepal has an open border with India, and a tariff structure substantially lower than India's could lead to re-export of radios from Nepal to India.

Television

The El Salvador ITV system[1]

Introduction

El Salvador began broadcasting ITV to a small number of seventh-grade students in 1969. By 1971, ITV broadcasts reached more than 30,000 in grades 7–9 with instruction in all core subject areas. ITV was introduced in El Salvador in the context of an over-all educational reform and was, moreover, the object of careful external evaluation from the outset of the reform. The final report of the evaluation, by Hornik, Ingle, Mayo, McAnany and Schramm,[2] contains a concise description of the reform and of the role of television therein. It may be quoted here in part by way of introduction:

> To remedy the numerous problems that had been inherited from previous administrations and to streamline an educational system whose goals and procedures had ceased to fit the needs of El Salvador, Minister of Education Beneke set forth a comprehensive, five-year reform plan in 1968. The plan was systematic and thorough in its approach, touching virtually every aspect of the educational system. The major reforms included:
>
> 1. Reorganization of the Ministry of Education.
> 2. Extensive teacher retraining.
> 3. Curriculum revision.
> 4. Development of new study materials.
> 5. Modernization of the system of school supervision.
> 6. Development of a wider diversity of technical training programmes in grades 10–12.
> 7. Extensive building of new schoolrooms.
> 8. Elimination of tuition in grades 7, 8 and 9 (in 1971).
> 9. Use of double sessions and reduced hours to teach more pupils.
> 10. A new student evaluation system incorporating changes in promotion and grading policies.
> 11. Installation of a national instructional television system for grades 7–9.
>
> Although some of these changes were enacted immediately, most were begun with the understanding that additional planning, experimentation and adjustment would be required and that major changes could only be introduced on an incremental basis. However, the five-year reform timetable was a

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[1] Abridged from Jamison *et al.*, op. cit.

[2] R. Hornik *et al.*, *Television and Educational Reform in El Salvador: Final Report*, Stanford University, Institute for Communication Research, 1973. (Research Report No. 14.)

strict one; it coincided with the single term of President Fidel Sanchez Hernandez and Minister Beneke was anxious to prevent the President's mandate from being undermined or stalled through bureaucratic opposition or delays.

The decision to use television as a major component of El Salvador's Educational Reform was neither imposed from the outside nor taken in a precipitous fashion. As far back as 1960, the possibility of introducing some form of educational television was being discussed, although there was no consensus and little knowledge about how television might help alleviate El Salvador's educational problems. Above all, the country lacked the capital and expertise necessary to initiate any large television project.

The initiative that led eventually to the establishment of El Salvador's national ITV system was taken by Lic. Beneke in 1961. During his ambassadorship to Japan, Beneke had been impressed by the role television played in that country's correspondence high schools. Anxious to stimulate the growth of something similar in his own country, Beneke sought the help of NHK (Nippon Hoso Kyokai, the Japan Broadcasting Corporation). NHK agreed to conduct a feasibility study in El Salvador and several engineers were dispatched for that purpose in 1962. The results of this study confirmed what Beneke had suspected; El Salvador possessed excellent topographical conditions for the installation of a national television network.

The initiative taken by Beneke was supported by former President Julio Adalberto Rivera, who established the first Educational Television Commission in the fall of 1963. The Commission was supposed to evaluate alternative uses for educational television with the goal of proposing a national plan. However, the Commission met sporadically and little progress was made until Beneke returned from Japan in 1965. Under Beneke's chairmanship, weekly meetings were instituted, and the Commission made a fresh start toward defining specific proposals for the use of television. . . .

By the end of 1966, the Commission had reached a consensus on a number of basic points. First, acknowledging the fact that their country had neither a reservoir of trained people nor sufficient economic resources to embark upon a large television project, the Commission decided that its initial efforts would have to be limited in scale, but flexible enough to permit expansion should circumstances permit. Second, the Plan Basico (grades 7–9) was selected to be the first level served by television, for it was the lack of opportunity and low quality of instruction at this level that was believed to constitute the 'bottleneck' to El Salvador's development. Instructional television, the Commission members believed, would compensate for the many unqualified secondary school teachers who, in turn, could be trained in a short time to become effective monitors within television classes. Third, the Commission concluded that ITV should be administered by an autonomous institute directly under the President with freedom to set its own personnel policies and to import the vast array of technical equipment that would be required. Finally, the Commission resolved to seek foreign financial and technical assistance so that ITV could be put on as firm a footing as possible from the outset (p. 8–11).

TABLE 14. Cost of ITV in El Salvador for third-cycle schools in thousands of

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Production											
Facility[2]					234	108	36	36			
Equipment[3]			50	270	40	966					
Operations[4]				300	370	410	490	490	490	490	540
Start-up[4]	50	50	380	360	260	210	200	200	100	50	
Videotape[5]				51	51	51			51	51	51
Transmission											
Facility[6]					26	12	4	4			
Equipment[7]						644					
Operations[8]				20	20	40	10	10	10	10	10
Reception											
Classroom remodelling[9]			1,090								
Equipment[10]			50		120	120	120	53	62	80	13
Replacement								50		120	120
TOTAL COSTS	50	50	1,570	1,001	1,121	2,561	860	843	713	801	734
Foreign aid and debt repayment[11]			(190)	(680)	(300)	(1,980)	(320)	(320)			
TOTAL COST TO GOVERNMENT	50	50	1,380	321	821	381	540	523	713	801	734
Number of students (in thousands)[12]				2	14	32	48	60	72	86	104

1. Cost data for 1966–73 are based mainly on R. E. Speagle, *Educational Reform and Instructional Television in El Salvador: Costs, Benefits, and Payoffs*. Washington, D.C., Academy for Educational Development, 1972. The cost data do not include teacher training (not considered by Speagle as part of ITV costs), the distribution and printing of teachers guides and student workbooks, nor maintenance and power costs for reception equipment (Speagle says the latter is extremely small).
2. *Production facility*. Ninety per cent of the costs of the Santa Tecla facility were allocated to production and 10 per cent to transmission, with the life of the air-conditioning assumed to be ten years and the facility life to be twenty-five years.
3. *Production equipment*. This assumes a ten-year life, with the cost of the Santa Tecla equipment allocated 60 per cent to production and 40 per cent to transmission.
4. *Production operations and start-up*. These are the same as in Speagle until 1974 when start-up costs are assumed to decrease over two years to a $50,000 level. After 1975 they remain at this level and are included in the cost of operations, which are based on Speagle's projection.
5. *Videotape*. It is not clear whether these costs are included in Table 2.1 of Speagle. They are added here, under the assumption of a five-year tape life, 300 hours of programming a year, and a cost of an hour-long videotape of $170.
6. *Transmission facility*. This is explained under production facility.

The cost of ITV in El Salvador

Cost pattern

Table 14 presents the basic cost pattern. It shows costs in various subcategories of production, transmission and reception for one year.

All costs are adjusted to take account of inflation, are expressed in

1972 United States dollars [1]

1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
			36	36							
	50	270	40	966							
540	540	540	540	540	540	540	540	540	540	540	540
		51	51	51			51	51	51		
			4	4							
				644							
10	10	10	10	10	10	10	10	10	10	10	10
13	13	18	13	18	18	18	13	18	18	22	18
120	103	62	200	133	133	116	80	213	151	151	134
638	716	951	934	2,402	701	684	694	832	770	733	702
			45	45	45	45	45	45	45	45	45
638	716	951	979	2,447	746	729	739	877	815	768	747
107	110	113	117	120	124	128	131	135	139	144	148

7. ***Transmission equipment.*** This is explained under production equipment.
8. ***Transmission operations.*** This represents the rental charge through 1971 for the use of commercial broadcast time. Beginning in 1972, operations are estimated to cost 25 per cent of the 1971 rental charge.
9. ***Classroom remodelling.*** This is the same as in Speagle, with an assumed twenty-five-year lifetime.
10. ***Reception equipment.*** Beginning in 1973, this is based on the number of students added to the system, an average class size of forty-five, and a cost per receiver of $200.
11. ***Foreign aid and debt repayment.*** Through 1973 this represents the actual size of foreign grants and loans. The loan portion of this aid is paid off with a ten-year grace period during which interest accumulates at 2 per cent and a thirty-year repayment period during which interest accumulates at 2.5 per cent. With our assumption of a 4 per cent annual rate of inflation these effective interest rates become −2 per cent and −1.5 per cent respectively. If there were no inflation present, value of the repayment amount would be almost three times as large. The repayment is scheduled as if the forty-year period for the total loan began in 1970.
12. ***Number of students.*** This is assumed to grow rapidly from 1972 to 1976 (about 20 per cent per year) after which a 3 per cent growth rate is accounted for mainly by population growth.

1972 United States dollars and are based on Speagle's analysis.[1] Foreign aid and debt repayment are shown under total costs. The numbers in parentheses show the total grant or loan money received. Beginning in 1980, the costs to the Salvadorian Government are computed by adding the loan repayment to the total incurred expenditures.

[1] R. E. Speagle, *Educational Reform and Instructional Television in El Salvador: Costs, Benefits, and Payoffs*, Washington. D.C., Academy for Educational Development, 1972.

TABLE 15. Costs of programme production in thousands of 1972 United States dollars

Cost category	Amortization period (years)[1]	Cost	Annualized cost[2]
Facility (building)	25	342	31
Facility (air-conditioning)	10	72	10
Equipment	10	1,326	193
Start-up	25	1,860	167
Videotape	5	153	38
Operations (recurrent)	—	—	540
TOTAL			979

1. The amortization period is the number of years the cost item is assumed to last; start-up costs are amortized over an assumed twenty-five-year life for the project.
2. The annualization was done with a social discount rate of 7.5 per cent per annum.

The table shows usage, which increases rapidly until 1976, and thereafter increases in proportion to the school-age population growth which is approximately 3 per cent a year.

The footnotes to Table 14 provide somewhat more information on the source of the figures in the various categories; readers interested in a detailed discussion of the various cost components should consult the comprehensive treatment by Speagle. This chapter will provide no further discussion of these component cost estimates except to expand briefly on the cost of programme production.

Programme production costs exceed the sum of transmission and reception costs by a factor of two or three. For this reason, it is important to examine these costs in some detail and Speagle[1] provides a breakdown of the operating costs of programme production. However, a very substantial fraction of programme production costs are capital costs and it is important—particularly for planners from other countries—to obtain an estimate of total production costs, not just the operating costs of programme production. Table 15, using cost data from Table 14, presents the component and total costs of programme production, including annualized capital expenditures at a 7.5 per cent discount rate; the total of $979,000 per year is almost twice the recurrent cost of $540,000 per year. At the estimated production rate of 1,000 twenty-minute programmes per year, the cost per hour of programme production comes to about $2,940.

The total cost function for ITV

Using the data from Table 14, it is possible to obtain a cost function for ITV in El Salvador. In this chapter the programme production and transmission costs are considered fixed; reception costs are variable with the number of students. The cost function we use, then, is:

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[1] Speagle, op. cit., p. 72–8.

$$TC\ (N) = F + V_N N$$

where: TC = total cost; N = number of students; F = fixed cost; V_N = variable cost per student; Start-up costs were treated as an initial capital investment in the system; they were annualized over the assumed twenty-five year lifetime of the system and included in F. The 1972 student enrolment estimate of 48,000 was used along with the assumption of an average of 170 hours of programme presentation per grade per year. The enrolment figures allow calculation of AC and AC/V_N; the programme presentation assumption allows computation of costs per student hour of viewing. The total cost equation (expressed in 1972 United States dollars) for the system is as follows, assuming a discount rate of 7.5 per cent.[1]

	Total cost equation	AC	AC/V_N	*Student-hour cost*
$TC(N)$ =	$1{,}116{,}000 + 1.10N$	24.35	22.14	0.143

With twice as many students using the system ($N = 96{,}000$), average costs fall to $12.73 and per student-hour costs fall to $0.075. This substantial reduction is possible because of the initially high value of AC/V_N.

The above total cost equation is for all inclusive costs; it is also of value to compute a cost equation that includes only costs to the Salvadorian Government.[2] To do this one must reduce the fixed cost com-

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[1] Jamison and Klees examined the sensitivity of the cost estimates to the value chosen for the social discount rate; increasing it from 7.5 per cent to 15 per cent increases AC by about 20 per cent. This is a substantial amount, due to the highly capital-intensive nature of the project. (See D. Jamison and S. Klees, *The Cost of Instructional Radio and Television for Developing Countries*, Stanford University, Institute for Communication Research, 1973. To appear in: *Instructional Science*.)

[2] In order to adjust all-inclusive costs for grants, one simply subtracts the amount of the grant in the given year from the all-inclusive costs of that year. Loans are somewhat more complicated because they must at some point be paid back. The loans negotiated by El Salvador have a ten-year grace period before repayment is to commence. Thus, in early years of the project the loans in a given year are, like the grants, simply subtracted from the all-inclusive costs. In later years the repayments must be added to the all-inclusive costs in order to obtain costs to the government.

Computing the amount to be repaid in each of the later years is complicated by lack of knowledge of the inflation rate of the dollar. The loans are negotiated in fixed dollar terms so that the higher the rate of dollar inflation the lower the real value of the loan repayments, that is, the lower the value expressed in fixed dollars (1972 dollars are used as the base in this report). The situation is exactly analogous to that of a home-owner with a mortgage; in times of high inflation he gains because the value of his debt is fixed in dollar terms. Inflation rates for the dollar are unpredictable even, it now appears, several months, much less ten years, in advance. For this reason, the value used in this chapter, 4 per cent, should be regarded as only a conservative estimate. Given the value of the loans, the interest rates they bear, their repayment schedules, and the rate of inflation for the dollar, one can use standard accounting formulase to determine the annual ponents of the above equation by an annualized equivalent of the grants and loans. To find this equivalent, the present value of the thirty-year loan repayment series was calculated, and the sum subtracted from the total amount of foreign grants and loans (the total amount was assumed to occur in the year 1970). The resulting figure was annualized over the twenty-five-year assumed lifetime of the project and subtracted from the fixed costs. The Government of El Salvador cost equation is as follows:

Government of El Salvador cost equation	*AC*	ACV_N	*Student-hour cost*
$TC(N) = 799{,}000 + 1.10N$	17.75	16.13	0.104

It should be observed that the net grant and loan contribution to the ITV system is substantial. At the 7.5 per cent social rate of discount, foreign contributions cover about 27 per cent of the system's cost. This 27 per cent is based on the assumption that 48,000 students per year use the system; as the entire cost of expanding the system is borne by El Salvador, the percentage of foreign contribution will decline as usage increases. Because of the high value of AC/V_N, however, the decline amounts to only a little over 25 per cent when student usage reaches the 104,000 projected for 1976.[1]

The cost equations of the preceding paragraphs provide a reasonably clear picture of system costs as a function of N, the number of students per year using the system. In order to assess accurately the actual average costs incurred, account must be taken of the time structure of student usage, and this is done in the computations of values for AC_{ij} that follow.

Average costs of ITV in El Salvador

The data in Table 14 suffice to calculate values of AC_{ij} for El Salvador for the years 1966 to 1988. Taking 1966 as year 1 (and therefore 1973 as year 8), one can compute all possible values of AC_{ij} both for all-inclusive costs and for costs to the government. These computations depend, of course, on the accuracy of the enrolment projections in the last row of Table 14 and deviations from those projections would induce corresponding deviations in average costs.

Figure 1 displays values of AC_{ij} graphically. This graph indicates that if the social discount rate is 7.5 per cent, the average costs through to

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repayment in terms of 1972 dollars. These repayments begin in 1980 and, as of that year, costs to the Salvadorian Government must be determined by adding the loan repayments to the all-inclusive costs.

[1] In comparing the average costs in total with those to the Salvadorian Government, it is an interesting fact that the latter is totally insensitive to the social discount rate. This results from a coincidental balancing of two factors: on the one hand, increasing the social discount rate increases capital costs but, on the other hand, it increases the value of foreign loans.

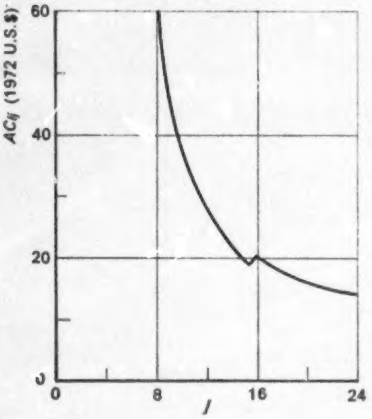

FIG. 1. AC_{ij} for the total cost of ITV in third cycle.

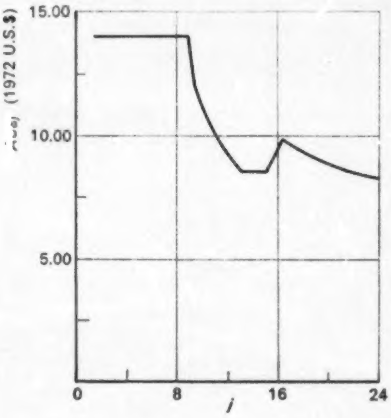

FIG. 2. AC_{8j} for the total cost of ITV in third cycle.

year 12 of the project (1977) will have been about $24 per student per year. What this means is that total expenditures up to 1977 divided by total student usage up to 1977 (each properly discounted) will equal $24. If the time horizon is extended to twenty-five years (1988) the result comes to about $1[illegible]. The bump in the curve that occurs near year 15 (1981) results from the need to replace production and transmission equipment at that time.

Figure 2 displays the same information as Figure 1 except that costs are viewed from 1973 rather than from the beginning of the project. It will be noticed that the scale in Figure 2 differs from that in Figure 1 and that values of AC_{8j} for j less than 8 are undefined (indicated by the flat part of the curve). From the time perspective of 1973, average costs through to year 12 (1977) are, of course, much less than the $24 of $AC_{1,12}$; the value of $AC_{8,12}$ is about $8.50 for a 7.5 per cent discount rate. This $8.50 is the total projected expenditure between 1973 and 1977 divided by the projected number of years of student use between now and 1977, each properly discounted. The small bump at year 15 on Figure 1 is much magnified in Figure 2; this is both because the fixed replacement costs are a larger fraction of average costs viewed from 1973 and because they are less discounted since by 1973 they are much nearer in the future.

Table 16 presents exact computations of AC_{ij} based on a 7.5 per cent discount rate and the figures in Table 14 for total cost. The top row of Table 16 corresponds to the graph in Figure 1 and its fifth row corresponds

Table 16. Average total costs from year *i* to year *j* for third-cycle schools, in 1972 United States dollars (interest rate = 7.5 per cent)

From year *i*	To year *j*										
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986	1988
1966		254.95	82.72	44.49	29.84	23.11	20.01	18.88	17.14	15.95	14.97
1969		134.63	60.50	34.24	23.71	18.73	16.53	15.96	14.59	13.67	12.89
1971			43.71	24.90	17.75	14.35	13.02	13.00	11.99	11.33	10.75
1972			17.92	13.55	10.95	9.45	9.15	9.80	9.18	8.80	8.44
1973				11.78	9.69	8.46	8.37	9.21	8.64	8.31	7.98
1974				9.75	8.52	7.58	7.73	8.77	8.23	7.92	7.61
1975					8.00	7.12	7.43	8.66	8.08	7.77	7.45
1976					6.95	6.48	7.09	8.58	7.95	7.63	7.30
1977						6.23	7.13	8.90	8.11	7.72	7.34
1978						6.51	7.55	9.57	8.47	7.96	7.50
1980							7.89	11.17	8.98	8.15	7.53
1984									5.21	5.58	5.32
1988											4.74

Table 17. Average government costs from year *i* to year *j* for third-cycle schools in 1972 United States dollars (interest rate = 7.5 per cent)

From year *i*	To year *j*										
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986	1988
1966		177.52	44.19	25.37	18.39	14.93	13.56	13.52	12.51	11.84	11.25
1969		70.79	24.48	16.28	12.96	11.04	10.47	10.92	10.25	9.81	9.40
1971			13.99	11.20	9.85	8.78	8.68	9.43	8.94	8.63	8.33
1972			11.25	9.84	8.98	8.10	8.15	9.03	8.57	8.29	8.01
1973				9.26	8.56	7.74	7.87	8.87	8.40	8.13	7.85
1974				9.75	8.52	7.58	7.78	8.89	8.38	8.09	7.80
1975					8.00	7.12	7.49	8.79	8.25	7.96	7.65
1976					6.95	6.48	7.16	8.73	8.14	7.84	7.52
1977						6.23	7.22	9.07	8.32	7.95	7.58
1978						6.51	7.68	9.78	8.72	8.22	7.77
1980							8.27	11.55	9.33	8.51	7.88
1984									5.56	5.92	5.64
1988											5.05

to the graph in Figure 2. Table 17 presents the same computations for costs to the Salvadorian Government instead of all-inclusive costs; except in the lower right-hand corner, costs in Table 17 are lower than corresponding costs in Table 16. The appropriate cost to use depends on one's vantage-point. At the time of El Salvador's initial decision, the long-run average cost to the government $AC_{1,25}$[1] in Table 17 was the most useful figure for El Salvador to consider; by 1973, for long-term planning, the values of $AC_{8,25}$ are perhaps most useful; on the other hand, for present short-term expansion or contraction decisions, the marginal costs are the most appropriate.[2] If El Salvador had not had grant and loan opportunities, the all-inclusive costs of Table 16 would be more appropriate.

In terms of what others can learn from El Salvador's experience, the most useful figure is perhaps the long-term average cost viewed from the point at which El Salvador commenced expenditure. At the 7.5 per cent discount rate, this figure, $AC_{1,24}$, is seen from Table 16 to be $14.97, say, $15. If the students view an average of 170 hours of ITV per year, the cost per student hour is $0.09. It should be borne in mind that these costs assume that the system continues through 1988 and, more importantly, that the rapid expansion of enrolments projected in Table 14 is in fact attained.

The cost of ITV is necessarily an add-on to whatever else may be provided for students. The introduction of ITV may, however, facilitate reduction of other costs and the next subsection considers very briefly the factors that may allow ITV costs to be offset.

Factors offsetting the cost of ITV

The principal cost of conventional instruction is the teacher's time and the offsetting factor to be considered here is the reduction of teacher's time per student. ITV costs can be offset by increasing the student-to-teacher ratio through increases in C or h_t or through decreases in h_s, where C = class size; h_t = number of hours per week of a full-time teacher; h_s = number of hours in school per week of a full-time student. If the mechanism involves increases in teacher-hours, teacher salary increases must be less than proportional to hour increases.

ITV in El Salvador has tended to reduce costs by increasing teacher-hours and class size. Counterbalancing these costs are the costs of providing ITV. By using the estimate of thirty-five students to a class and twenty-five hours as estimates of both student-week and teacher-week, the student/teacher ratio was 35 : 1. The instructional expenditure per student was thus $52 per year. Had the reform been mounted without

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[1] 1966 corresponds to year 1 and 1988 corresponds to year 24.

[2] A more detailed analysis of El Salvador ITV costs, including discussion of expanding the system to the first and second cycles, may be found in Jamison and Klees, op. cit.

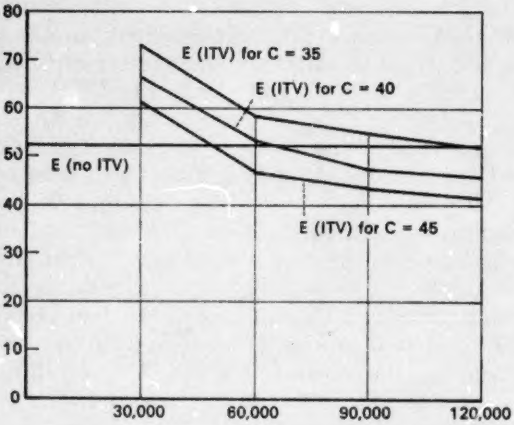

FIG. 3. Instructional expenditures in dollars per student per year: *E*(no ITV) and *E*(ITV). (*N*=number of students using ETV; C=class size.)

ITV and traditional size classes, that would have been the cost per student.

However, ITV was introduced, and accompanying it were two other changes affecting cost per student. Average classroom size was increased, as smaller third-cycle schools were closed and more students matriculated at the remaining schools. At the same time, teacher load was increased from twenty-five to thirty-five hours (an increase of 40 per cent) while teacher salaries were only increased by 20 per cent to $2,165. While it cannot be flatly asserted that such changes would not have occurred unless ITV had been introduced, this may be a reasonable assumption. Certainly the ministry planners believed that one of the advantages of extending ITV to primary schools would be 'to help the teacher who sees himself as overburdened by his work day with double sessions'.

Given the longer work week, the teacher cost per student equals the teacher wage divided by the student-to-teacher ratio; i.e., it equals $\$2{,}165/S$; since $S = (h_t/h_s)C = (35/25)C$, the teacher cost per student equals $\$1{,}546/C$, where C is the class size after the introduction of ITV. In addition to teacher costs, one must consider television costs per student to the government; the equation giving costs to the government summarized these expenditures. The annualized ITV costs per student are seen from that equation to equal ($\$799{,}000 \div N) + \$1.10$, where N is the number of students using the ITV system. The sum of this plus teacher costs give the per student costs with ITV, $E(\text{ITV})$:

$$E(\text{ITV}) = \$1{,}546/C + \$799{,}000/N + \$1.10.$$

It is not yet clear what the average class size will become after El Salvador's educational reform is fully implemented. In order to illustrate how class size and N jointly affect the per student costs, Figure 3 shows how E(ITV) varies with N for three values of C: $C = 35$; $C = 40$; $C = 45$.

Figure 3 also shows E(no ITV), the assumed instructional cost if ITV had not been introduced, of $52. E(no ITV) does not, of course, vary with N. All points on the E(ITV) curves that lie below the E(no ITV) curve indicate combinations of class size and total enrolment that result in having lower instructional costs per student with ITV than without. For example, if $C = 40$ in Figure 3, this indicates that with more than 60,000 students using ITV, the cost per student per year would be less with the ITV system than without the changes in class size and teacher hours accompanying the introduction of ITV. It thus seems quite possible that the use of ITV in the reform in El Salvador will be accompanied by a reduction in unit cost.

Mexico's Telesecundaria[1]

The problem for Mexico was to provide primary and secondary education schooling to rural areas. In 1966, experiments began with a system of instructional television known as Telesecundaria.

The system

Organization and technical characteristics

The system started with closed-circuit broadcasting to an experimental school in Mexico City.

Eighty-three seventh-graders divided into four classes received television instruction in standard subjects. An evaluation for the year 1966/67 indicated that this had been successful and open broadcasting began for 6,569 seventh-grade students in 304 classrooms all over Mexico.

Telesecundaria classes are usually held in premises provided by local authorities and involve the same curriculum and goals as the traditional

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[1] Abridged from Jamison *et al.*, op. cit.

Mexican secondary-school system. The teachers are classroom co-ordinators drawn from the ranks of fifth- and sixth-grade primary schools and they are paid by the federal government. They give the full range of instruction in all subjects for seventh, eighth and ninth grade. These co-ordinators are supplied with a monthly outline and schedule and pupils can buy workbooks.

Television teachers and producers are recruited from schools and are paid on an hourly basis. They are given special training in elocution, television teaching, script-writing and the use of audio-visual aids. Producers are given extensive technical training in audio-visual instruction as well as studio management. Telesecundaria believes it best to train academic specialists to be television producers.

In a typical week, students receive about thirty televised lessons which last about twenty minutes. The remaining forty minutes are for preparation and follow-up. On Saturday mornings, students receive one hour of television and the rest of the morning is reserved for the classroom co-ordinators.

Most broadcasts are live. Each teacher has one hour in the studio to rehearse and deliver a twenty-minute lesson.

Mexican law requires commercial broadcasters to donate 12.5 per cent of broadcast time for government use. The Telesecundaria system was initiated and until recently operated under the auspices of the Audio-visual Department of the Mexican Secretariat for Public Education (SEP). The development of Telesecundaria has been limited because it relies solely on Channel 5 which gives it about 40 per cent of its broadcast time. It is also limited in range. Because of this, a project was initiated in 1969 to send taped lessons by plane to the State of Sonora. This was discontinued because of administrative and scheduling difficulties.

Utilization

Table 18 shows student enrolment.

Each year a typical student receives about 1,080 twenty-minute programmes representing about 360 hours of instructional lessons.

TABLE 18.

	School year				
	1967/68	1968/69	1969/70	1970/71	1971/72
Seventh grade	6,569	10,916	12,175	14,499	12,432
Eighth grade		5,324	8,240	9,459	9,194
Ninth grade			5,473	6,997	7,350
TOTAL	6,569	16,240	25,888	30,955	28,976

TABLE 19. Costs of the ITV components of Telesecundaria and utilization

	1966	1967	1968	1969	1970	1971	1972	1973
Production								
Facility[1]	64	64						
Equipment[2]	162	162	60	60	60	60		
Operations[3]	108	228	337	444	444	444	444	444
Transmission								
Operations[4]			17	35	52	52	52	52
Reception								
Equipment[5]		1	85	109	122	61		12
Replacement[6]							1	85
Maintenance and operations[7]			9	20	32	38	38	39
TOTAL COSTS	334	455	508	668	710	655	535	632
Number of students (in thousands)[8]			7	16	26	31	29	30

1. This includes only the costs of the four television studios, as other production and administrative operations at present utilize excess space within the Audio-visual Department of SEP. There are four studios, constructed over a two-year period, at a cost of $32,000 per studio, and they are assumed to have a twenty-year life.
2. This includes the costs of studio equipment and videotapes. Studio equipment cost $204,000, was purchased in the two years prior to initial operation, and is assumed to have a ten-year life. The present stock of 1,500 hour-long videotapes, costing $240 per tape, was purchased over the first six years of the project. Tapes are assumed not to be erased for re-use, and 10 per cent of the programming is assumed to be taped (as was the case in 1972). Therefore the present stock of tapes will last about twelve years, after which it is assumed that tapes will be purchased as needed.
3. This includes the costs of production administration, maintenance and teleteachers. These costs are assumed to remain constant, in real terms, at their respective 1972 values of $220,000, $120,000

Effectiveness

As reported in Klees[1] and Mayo *et al*,[2] pre-tests and post-tests in Spanish, matematics, and chemistry were given to a random sample of ninth-grade students in Telesecundaria and traditional systems over one semester period in 1972. The score on pre-tests were about the same and gains by the Telesecundaria group were somewhat higher than those for the direct-teaching group (the difference in gain scores was statistically significant at the 0.01 level) in all three groups.

Klees[3] compares the two systems through regression analysis—controlling a large number of variables: student background, attitudes, aspirations, teacher education, experience, classroom, behaviour and class size—and finds television contributes significantly.

Once the Telesecundaria system was transferred from SEP to the regular secondary-school division within the Secretariat for Public Education (SEP), expansion was made more possible.

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[1] S. Klees, *Instructional Technology and Its Relationship to Quality and Equality in Education in a Developing Nation: a Case Study of Instructional Television in Mexico*, Princeton, N.J., Educational Testing Service, 1975. (Doctoral dissertation, Stanford University, 1974.)

[2] J. Mayo, E. McAnany and S. Klees, *The Mexican Telesecundaria: a Cost-effectiveness Analysis*, Stanford University, Institute for Communication Research, 1973. (Reprinted in: *Instructional Science*, 1975.)

[3] Klees, op. cit., chapter V.

in thousands of 1972 United States dollars

1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
		102	102	29	29	29	29	29	29	29	29	29
444	444	444	444	444	444	444	444	444	444	444	444	444
52	52	52	52	52	52	52	52	52	52	52	52	52
24	24	12	24	24	24	24	24	24	36	24	36	24
109	122	61	1	97	133	146	73	25	121	157	170	147
41	43	44	46	48	50	52	54	56	60	62	66	68
670	685	715	669	694	784	747	676	630	742	768	797	735
32	34	35	37	39	41	43	45	47	50	52	55	57

and $104,000. In the first three years of the project these costs are assumed to be proportional to the number of grades covered.

4. Since transmission time is donated, this figure reflects an estimate of the costs of broadcasting 1,080 hours annually on a system of the same size and power as Channel 5. Lower costs in early years reflect the reduced hours of broadcast resulting from fewer grades covered.
5. The price of a television receiver is assumed to be $280, which is somewhat high so as to include the cost of antennae, where needed. The number of receivers needed is assumed to be proportional to the number of students enrolled, with the average class size estimated at twenty-three students.
6. This assumes a five-year life for television receivers.
7. The cost of maintaining and operating the reception equipment each year is assumed to be 10 per cent of the total costs of reception equipment in operation in any year.
8. Prior to 1973 the actual number of students in the system is utilized. It is hypothesized that after that time enrolment grows at a rate of 5 per cent annually.

From a more macroscopic level of the system effectiveness, both Klees and Mayo *et al.* report on the relative potential of the two systems to enrol students and enable them to graduate: this would satisfy a social demand for secondary schooling. Both systems had identical dropout, repetition, promotion and graduation rates. The Telesecundaria system costs relatively less and could enrol 60 per cent more students with a budget equal to that of a traditional system.

System costs

Year-by-year costs

Costs presented in Table 19 are total costs to Mexico: local communities, students and families, other groups within the private sector, direct government outlays.

They are based on the assumption that student enrolment grows at a rate of 5 per cent annually—and that it continues to function in the present eight-state region reached by Channel 5.

Annualized cost functions

Based on the information presented in the previous subsection, we can derive an approximate annualized cost function for the instructional television component of Telesecundaria, as follows:

$$TC\ (N, h) = F + N_N\, N + V_h\, h,$$

where: TC = total system costs; N = the number of students enrolled in the system; h = the number of hours of programming broadcasts; F = fixed system costs; V_N = variable cost per student; and V_h = variable cost per hour.

Cost functions for each ITV system component—production, transmission and reception—at alternative social rates of discount of 0 per cent, 7.5 per cent and 15 per cent. Calculations are based on the information in Table 19 and the accompanying footnotes.

Production costs vary with the number of hours the system broadcasts. Studios and studio equipment are treated as capital costs to be annualized. Personnel, equipment maintenance, videotapes are recurrent costs. Production costs = $472 per hour, assuming the future is not discounted, $490 per hour with 7.5 per cent rate of discount and $513 at a 15 per cent interest rate.

Transmission costs are assumed to vary directly with the number of hours of programming broadcast. Calculations are based on the imputed operating costs of Channel 5 and there is not enough information to break down costs into capital and recurrent. Therefore we use the $52,000 annual operating costs figure, which yields a cost per hour broadcast of $48.

Reception costs vary with the number of students in the system. Treating the television receiver as a capital expenditure whose cost is annualized over a five-year lifetime, and maintenance and operational costs as recurrent costs, and assuming an average class size of twenty-three students, the total costs of reception amount to $3.65 per student when the future is not discounted, $4.23 per student at a 7.5 per cent discount rate and $4.85 at a 15 per cent rate.

The total cost function and average cost information for the year 1972 may be summarized as shown in Table 20.

This table assumes: (a) an enrolment of 29,000 students; and (b) that each student views about 360 hours of instructional television lessons.

The relatively low value of the ratio of average cost per student (AC_N) to variable cost per student (V_N) indicates that some economies of scale have already been achieved, although costs per student could be lower if enrolments expanded.

TABLE 20. Total cost function and average cost for 1972 in 1972 United States dollars

	Total cost equation	AC_N	AC_N/V_N	Cost per student-hour
$r = 0\%$	$TC = 3.65\ N + 520\ h$	23.02	6.31	0.064
$r = 7.5\%$	$TC = 4.23\ N + 538\ h$	24.27	5.74	0.067
$r = 15\%$	$TC = 4.85\ N + 561\ h$	25.74	5.31	0.072

Table 21. Average costs of the ITV components of Telesecundaria from year *i* to year *j* in 1972 United States dollars (interest rate = 0 per cent)

From year *i*	To year *j*									
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986
1966	185	55	35	30	27	25	24	22	21	20
1969		33	25	24	23	21	21	20	19	18
1971			20	20	20	20	19	18	18	17
1972			18	20	20	19	19	18	17	17
1973				21	21	20	19	18	17	17
1974				21	20	19	19	18	17	16
1975					20	19	19	17	17	16
1976					20	19	19	17	17	16
1977						18	18	17	16	16
1978						18	18	16	16	15
1980							17	15	15	15
1984									15	14

Average annual costs

The information presented in the year-by-year cost table above can be used to derive summary measures of the average costs per student in the project, which takes into account changing utilization over time. Specifically, we can compute AC_{ij}, that is, the average cost per student from year i to year j where:

$$AC_{ij} = \frac{\sum\limits_{k=i}^{j} C_k/(1 + r)^{k-i}}{\sum\limits_{k=i}^{j} N_k/(1 + 5)^{k-i}}$$

The formula above provides a measure of average costs that discounts the future for both costs and student utilization. This provides a more interesting and useful measure than the average cost figure derived in the previous section since the latter only takes into account utilization at one point in time. The AC_{ij} measure also allows the project planner to determine the length of time the project must continue to permit unit costs to fall to a reasonable level. It also permits one to look at project costs from different point in time over the life of the project.

Tables 21, 22 and 23 present the AC_{ij} for selected years of the instructional television component of Telesecundaria at social rates of discount of 0 per cent, 7.5 per cent and 15 per cent respectively. They serve to illustrate several points. First, costs decrease quite rapidly if Telesecundaria is projected to continue for more than a few years. For example, if Telesecundaria were to be discontinued next year, the average cost per student over the lifetime of the project ($AC_{1966,1976}$) would be only

TABLE 22. Average costs of the ITV components of Telesecundaria from year *i* to year *j* in 1972 United States dollars (interest rate = 7.5 per cent)

From year *i*	To year *j*									
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986
1966	198	59	39	33	30	28	27	25	24	23
1969		33	26	24	23	22	22	21	20	19
1971			20	20	20	20	20	19	18	18
1972			18	20	20	20	19	18	18	17
1973				21	21	20	19	18	18	17
1974				21	21	20	19	18	18	17
1975					20	19	19	18	17	17
1976					20	19	19	17	17	16
1977						18	18	17	16	16
1978						18	18	17	16	16
1980							17	15	15	15
1984									15	14

TABLE 23. Average costs of the ITV components of Telesecundaria from year *i* to year *j* in 1972 United States dollars (interest rate = 15 per cent)

From year *i*	To year *j*									
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986
1966	210	64	43	37	34	32	30	29	28	28
1969		33	26	25	24	23	23	22	21	21
1971			20	20	20	20	20	19	19	19
1972			18	20	20	20	19	19	18	18
1973				21	21	20	20	19	18	18
1974				21	21	20	19	19	18	18
1975					20	19	19	18	18	17
1976					20	19	19	18	17	17
1977						18	18	17	16	16
1978						18	18	17	16	16
1980							17	15	15	15
1984									15	14

\$30 (at a 7.5 per cent interest rate). Assuming a twenty-year lifetime, the average cost ($AC_{1966,\,1986}$) would be considerably less: \$23.

Second, we see that in general, the project cost picture changes as we examine it from different points in time and with different assumptions as to its duration. As we assume a longer project lifetime, average costs usually decline, due primarily to enrolment increasing faster than total costs (as is true in most instructional-technology projects). We also see that, in general, the further advanced the project, the less expensive it is to continue, due primarily to many initial project-development expenses becoming sunk costs, and also due to enrolment expansion.

TABLE 24. Annual cost per student of Telesecundaria *v.* direct teaching in 1972 United States dollars[1]

	Direct teaching	Telesecundaria
Traditional components[2]		
Administration	6	6
Classroom teachers[3]	203	88
Facilities (fully equipped classroom)	11	11
Student costs (books, uniforms, etc.)[4]	28	20
SUB-TOTAL	248	125
ITV components[5]		
Production	0	18
Transmission	0	2
Reception	0	4
SUB-TOTAL	0	24
TOTAL	248	149

1. More detailed information concerning the basis of these cost calculations may be found in Klees, op. cit., Table III.1, Table III.5 and Appendix A and in Mayo *et al.*, op. cit., Table II.3, Table II.7 and Appendix B.
2. Administrative and classroom facility costs for both systems are equal to those given for the Telesecundaria system in the two sources above.
3. As stated in the above sources, traditional system secondary-school teachers earn $4,680 per year while Telesecundaria teachers are drawn from the ranks of primary school teachers and earn only $2,016 per year. Cost per student estimates assume an average class size of twenty-three.
4. Students and their families pay the costs of books, supplies, and uniforms. Uniforms cost $4 per student in either system. Books for the Telesecundaria system are $8 less per student than those used for the traditional system; the latter uses general textbooks, while the former uses books especially prepared for, and keyed to, the instructional television lessons.
5. These costs are taken from the section 'System Costs', above, assuming 29,000 students in the system as in 1972 and a 7.5 per cent social rate of discount.

Finally, we observe that the choice of a discount rate is quite important; as the opportunity costs of resources become greater, so do the real costs of the project. Neglecting the discount rate (that is, choosing a zero discount rate), as many cost studies unfortunately do, serves to understate project cost substantially, even more so than the average cost figure derived in the previous section for 1972, since utilization was not discounted in this latter figure. For example, taking the average cost per student from 1966 to 1986 (i.e. assuming a twenty-year lifetime for Telesecundaria) and not taking the value of resources over time into account (i.e. using a zero discount rate) can result in understating costs by almost 30 per cent if the appropriate rate is 15 per cent (i.e. $20 per student *v.* $28 per student).

Discussion

Telesecundaria would cost much less than the El Salvador system if it were expanded to urban areas. The AC_{ij}'s for Telesecundaria are higher than those for El Salvador because of the substantially higher utilization projected for the latter system.

TABLE 25. Annual cost per student of Telesecundaria *v.* direct teaching operating in an urban environment in 1972 United States dollars[1]

	Direct teaching	Telesecundaria
Traditional components[2]		
Administration	50	50
Classroom teachers[3]	94	40
Facilities (fully equipped classroom)	28	28
Student costs (books, uniforms, etc.)	28	20
SUB-TOTAL	200	138
ITV components[4]		
Production	0	1
Transmission	0	0
Reception	0	4
SUB-TOTAL	0	5
TOTAL	200	143

[1] More detailed information concerning the basis of these cost calculations may be found in Klees, op. cit., Appendixes A and B.

[2] Administrative costs and classroom facility costs are higher than those assumed in Table 24 which reflected Telesecundaria's historical experience; the cost figures utilized above are the actual historical costs of the traditional direct teaching system in Mexico, which has a much higher administrative overhead and employs much more expensive classroom facilities than does the rural-based Telesecundaria system.

[3] Classroom teachers for both systems are less expensive per student than was the case in Table 24 since in urban areas the average class size is 50 students.

[4] These costs are taken from the section on system costs, above, assuming a 7.5 per cent social rate, and an enrolment of 580,000 students, which was that of the traditional system in the eight-state region in 1972. Transmission costs per student are virtually zero with such a high utilization.

One of the main reasons the over-all cost of Telesecundaria is low is its low production cost.

Cost comparison with the traditional system

Telesecundaria is one of the most interesting ITV systems in the world because it is one of the few that has been shown to be cost-effective in relation to the traditional direct-teaching system.

Table 24 presents the costs per student of the Telesecundaria system as a whole, including the traditional components and ITV components and costs per student necessary for the traditional system to work.

We find the traditional system in rural areas much more expensive (65 per cent higher) than Telesecundaria: $248 per student for the traditional system versus $149 per student for Telesecundaria. If more than 29,000 students received Telesecundaria, the figure would be even lower: for 500,000 students, Telesecundaria would come to $130 per student.

One of the apparent reasons (seen in Table 24) that Telesecundaria is cheaper is its use of lower-salary teachers and lower-cost textbooks. This is because Telesecundaria uses primary-school teachers and as

TABLE 26. Sources of funding for Telesecundaria *v.* direct teaching in 1972 United States dollars

Source of funding	Direct teaching[1] Cost/Student/Year	%	Telesecundaria[2] Cost/Student/Year	%
Government	168	64	112	75
Locality (student, families and parents' organizations)	32	16	35	24
Private industry (Channel 5)	—	—	2	1
	200	100	149	100

1. These costs reflect the historical costs of operating the traditional direct-teaching system (see Mayo *et al.*, op. cit., for details). Students and their families pay $28 for books and uniforms, plus a $4 annual fee that the Secretariat of Public Education collects and contributes to system operation costs.
2. For Telesecundaria, Channel 5 contributes the transmission facilities, while students and their families are required to pay the costs of books and uniforms ($20 per student per year), the cost of constructing and maintaining classroom facilities ($11 per student per year) and the cost of reception equipment and maintenance ($4 per student per year). The $4 annual fee is waived by SEP for Telesecundaria students.

long as their salaries are lower than secondary-school teachers this difference will persist.

Expansion alternatives

The analysis is based on the works of Klees, and Mayo *et al.*, already mentioned. If Telesecundaria were to expand enrolment within the eight-state region and remain in rural areas, the annual marginal cost per student of expansion would be $129, but if Telesecundaria were to expand into urban areas in direct conjunction with, or as a replacement for, the traditional direct-teaching system, its costs would be very different.

Table 25 represents an approximation of costs of Telesecundaria if it were introduced into urban areas, compared with those of the traditional system.

If Telesecundaria coverage were to be expanded nation-wide, a different transmission system would be needed. With 1 million students in such a system, the cost per student would come to $145, thus leading to a total saving of $55 million annually. This would probably lead to hard political opposition; hence, expansion will probably have to be kept to the rural areas. If the expansion of Telesecundaria takes place over an extended period of time and does not threaten the position of existing secondary-school teachers, it could become a good alternative to the traditional system. The money saved could be used in giving more education to rural youth.

System financing

It is important not only to analyse the total costs of a given system but also to look at who is paying these costs.

Table 26 shows costs, on a per student basis and by funding source, that have been operative for Telesecundaria and the traditional secondary-school system.

Conclusions

Telesecundaria is cost-effective. It was initiated entirely by the country utilizing it, without external financing or technical assistance. Subject-matter tests did not show large gains for either the Telesecundaria student group or the traditional group. But Telesecundaria is significantly more *cost-effective* than the traditional secondary-school system and alternative expansion possibilities should be taken into consideration.

But a system which encourages the migration of bright rural youth to overcrowded Mexican urban areas that already have significant unemployment problems may not be a *cost-beneficial* system. And this is a problem common to most developing countries. Attention must be given to the goals toward which this potential will be directed.

Programmed instruction

A programmed-instruction project in Central Africa[1]

1 Background data

1.1 *State of the project*

The project was launched by Unesco in 1967 and subsequently taken over by the Senior Teacher Training College of Central Africa (ENSAC), Brazzaville, with financial assistance from Unesco and subsequently from the United Nations Development Programme (UNDP). By the date of the mission of May 1974, sufficient time had elapsed for it to be possible to distinguish fairly clearly the various stages in the project's development. The mission identified three such stages:

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[1] This study is based on data contained in two reports prepared by Mr. G. Nihan and Mr J. Pocztar following their mission to Brazzaville (May 1974): *Les coûts d'un Cours EP: l'Expérience EP en Afrique Centrale* (July 1974); *Evaluation du Project d'EP en Afrique Centrale* (Unesco, September 1974). The reports in question were mimeographed documents, of which only a limited number of copies were run off.

1. From 1967 to 1969: the opening period was one of trial and error, owing to inadequate planning and organization. Production was tentative, still feeling its way, and only a few programmed sequences were completed.
2. From 1969 to 1971: Three phases were distinguished in this period, both for purposes of the case study and because this division corresponded to types of activity that varied in range and intensity:
   (A) In July 1969 a 'production course' was held with the help of Unesco consultants, general lower-secondary school-teachers from the People's Republic of the Congo and from other Central African countries, and the Unesco project expert. Production was started all over again from the beginning and, in the space of a month, fifty-six sequences were produced in four subjects. Some of these were evaluated. In this connexion, the study carried out by the consultants in 1974 arrived at an important conclusion: the formula of a concentrated 'factory production course' is preferable to that of dispersed and staggered production. The advantages are not just financial but above all organizational: the various tasks involved in the programming process can more easily be rationalized when prototypes of validated sequences are already available in large numbers. Concentrated production also facilitates concentrated and mass reproduction, and hence savings in time and money.
   (B) In 1969–70 the programmed-instruction (PI) team validated fifteen of the fifty-six sequences produced, produced seventeen others and reproduced them in 500 copies used by 500 pupils in the bottom form of three general lower-secondary schools in Brazzaville. Each copy was used once by each pupil. The sequences were corrected and revised for final production.
   (C) In 1970–71 1,200 copies of these thirty-two sequences were reproduced and studied by 2,250 pupils from ten general lower-secondary schools in and around Brazzaville. Each sequence was used on average twice, which demonstrates an original attempt at rationalizing the programming process by modifying the 'utilization' factor in order to improve output from the various phases.

(For reasons of convenience, we will refer to the three phases of this period as A, B and C.)

3. In 1971–72 the PI service team of ENSAC decided to make large-scale use of the sequences produced. The aim was to reach close

> to 20,000 pupils, re-using each sequence an average of three times, which called for the production of from 6,000 to 8,000 copies. The scale of the operation was such that only a few sequences were produced. The desired use was not achieved because of the lack of a precise estimate of requirements in material, equipment and staff. From this failure the proper approach was learnt, but it proved impossible to apply it because of lack of financial resources, which had been grossly underestimated. The lessons drawn from this unfortunate experience provided the basis, however, on which to envisage a subsequent phase, which will be analysed in the next section, 'Costs'.

(This phase, whose essential aim is mass production, will be referred to as D.)

1.2 *Analysis of the period 1969–71*

1.2.1 *The reasons for this choice*

This period was chosen despite the fact that it did not lead to truly generalized use or, to employ the stock phrase, to true development. The reason is that the data are extremely precise in regard to production and reproduction in phases B, C and D.

Production appears as a fixed cost in relation to reproduction in phases B, C and D. In B and C, reproduction was limited (500 and 1,200 copies) and 'amateur' in that ordinary office equipment was used: chiefly stencil and duplicator. Page assembly and stapling of booklets were done by lower-secondary pupils and not by personnel detached for the purpose. Phase D moves on to an industrial-style approach in view of the number of booklets to be reproduced (32 sequences × 8,000 copies = 256,000 sequence-booklets). Duplication gives way to offset, stencil to photo-electric processes and zinc plates, hand stapler to electric stapler, office trimmer to a printer's electric guillotine; the amount of paper progresses from a few hundred kilos to several dozen tons. The work now has to be planned and systematized, by splitting it up into the successive operations involved.

1.2.2 *Advantage of the period chosen for the case study*

This results from several factors.

First, the ready access to data concerning the time and cost of production, reproduction and the following stages. The period is specially revealing not only from the analytic point of view but also in practice, since the way in which the problems of rationalizing the programming process were tackled can be studied.

Second, PI is used in the classroom, with the help of teachers who in fact play the part of monitors. Hence it is not entirely substitutive, but has a supportive function. The PI costs are costs added to the usual cost of instruction. Thus from the institutional point of view, it is not

TABLE 27. Costs of production, reproduction, distribution and promotion for thirty-two programmed instruction sequences in mathematics, People's Republic of the Congo (bottom form of general lower-secondary schools) in 1974 United States dollars

Operation	Phases								
	Sequences 1–15 A (500 copies)			Sequences 16–32 B (500 copies)			Final sequences 1–32 C (1,200 copies)		
	Fixed cost	Variable cost	Total	Fixed cost	Variable cost	Total	Fixed cost	Variable cost	Total
Preparation (labour)	776.2	—	776.2	—	—	—	—	—	—
Production (labour)	6,492.4	—	6,492.4	8,276.1	—	8,276.1	1,129	—	1,129
Supervision (labour)	1,222.2	—	1,222.2	756.5	—	756.5	252.1	—	252.1
Validation (labour)	—	—	—	—	—	—	919.1	—	919.1
Depreciation	190	—	190	557	—	557	179	—	179
Recurrent cost	...	—	...	...	—	...	...	—	...
TOTAL PRODUCTION	8,680.8	—	8,680.8	9,589.6	—	9,589.6	2,479.2	—	2,479.2
Reproduction									
Depreciation of machinery	3.8	2.4	6.2	4.4	2.7	7.1	8.2	12.1	20.3
Labour	600	536.8	1,136.8	233.2	57.2	290.4	439.2	253.6	692.8
Materials	65	146.7	211.7	73	167.3	240.3	134	751.8	885.8
Depreciation of premises	44.7	9.6	54.3	50.6	10.7	61.3	95.2	48	143.2
Power for machinery	0.2	0.5	0.7	0.2	0.5	0.7	0.3	1.7	2
TOTAL REPRODUCTION	713.7	696	1,409.7	361.4	238.4	599.8	676.9	1,067.2	1,744.1
Distribution									
Labour	—	—	—	—	—	—	453.7	—	453.7
Travel expenses	—	—	—	—	—	—	427.3	—	427.3
TOTAL DISTRIBUTION	—	—	—	—	—	—	881	—	881
Promotion	...		...	...		...	...		...
TOTAL	9,394.5	696	10,090.5	9,951	238.4	10,189.4	4,037.1	1,067.2	5,104.3

really a system. It would begin to become one if, for example, its use resulted in combining several classes under a single monitor, thus freeing teachers for other tasks. In this case, there really would be substitution (the possibility is worth considering where teachers do not possess the standard of competence required, for example, or where teachers having the necessary qualifications are too few in relation to the number of pupils).

2 Costs

2.1 *Costs of production, reproduction, distribution and promotion for thirty-two programmed-instruction sequences*

Table 27 shows the costs of the various production, reproduction, distribution and promotion operations for thirty-two programmed instruction sequences in mathematics for the bottom form of general lower-secondary schools in the People's Republic of the Congo.

2.2 *Comments*

Certain comments arise in connexion with Table 27:

1. Times and costs are specific. They are valid only in their own context and for a particular aspect of the process of implementing a programmed-learning course.

   It is nevertheless interesting to note that the unit costs for the preparation of a sequence in the first and second phases are almost identical ($579 to $564), although the production process is entirely different. In the first case, in addition to the Unesco consultants, teacher-trainees took part in the work and each sequence required an average of 70.3 hours to produce; in the second case, an average of 42.3 hours only was needed, because production was undertaken by the Unesco expert and national teachers associated with the project. Nevertheless, the lower cost of trainees made up for their lack of skill. Thus one factor seems to offset the other, and it would be interesting to check the significance of this later, in relative terms, in relation to the results obtained through other surveys.
2. On the other hand, the reproduction costs for phase A were unusually high, for such mechanical jobs as binding were carried out by the consultants and trainees themselves, whereas in phases B and C they were mainly left to volunteer pupils.

   This prompts the observation that, as far as future prospects are concerned, the second phase is more representative of reproduction costs during an experimental period (as explained above, phase C, with a run of 1,200 copies, was not really necessary from the pedagogical point of view).
3. Distribution costs in the first two phases have been omitted, since the experiment took place in the schools of Brazzaville, as opposed to phase C, where booklets were distributed throughout the country.

4. There seemed no point in adding up the total cost for the three phases, since the actual execution of the programme did not require all that amount. On the other hand, it is interesting to note that if the average cost of a sequence is calculated on the assumption that it will be produced by the methods described for phase A and reproduced by the methods of phase B, the unit totals come to $578.80 and $35.30 respectively, making a total of $614.10 for a one-hour sequence for 500 pupils. Thus the optimum cost of a one-hour experimental sequence comes in this case to $1.25 per pupil.

   This total should not, however, be considered solely within the strict context of a programme experiment. The cost is modified if the system goes into general use, as already shown by the same calculation applied to the reproduction of 1,200 copies (for use by 1,200 pupils), since the hourly PI cost falls to $0.53. This is due to the fact that there is a fixed production and reproduction cost (depending on the number of copies) which necessarily involves different unit costs according to the scale of use of the sequences. Without delving further into questions of economic theory, suffice it to say that what are needed are sufficient data to be able to produce a graph of average costs based on the application of programmes at different levels and using different means of reproduction. In this way, it could be shown that, given the actual structure of total costs, the unit cost, i.e. the cost per pupil-hour of a widely disseminated PI course, can be roughly equivalent to the cost of printing the course booklet. This is an important point, for the opinion is still widespread that production costs for such courses are too high to allow PI to be used on an operational footing.

2.3 *Conclusions*

As previously stated, this document is, at the present stage, a working instrument and no important conclusions can be drawn from it concerning the costs of programmed learning. The phase of widespread use of production has yet to come and it will have to be studied at a later stage in order to obtain a more accurate idea of unit costs. In order to evaluate these correctly, fixed costs must be distinguished from variable costs. The latter are determined, *inter alia*, by the production factors employed, the choice of which itself depends on the chosen volume of production. Thus what has to be found is the cheapest possible combination of these factors which is capable of producing a specific number of sequences.

It should further be borne in mind that, as in Brazzaville when the PI booklets were used several times by pupils, production and reproduction costs have to be regarded as investment costs to be amortized in the same way as capital expenditure in a conventional education system. In order to reduce the calculated amortization cost to a minimum, the programmed courses accordingly have to be put to intensive use. Once again, optimum conditions were never achieved in the phases analysed, since the costs under consideration relate to an experimental period only.

The fact is that a number of elements are missing and it is impossible, at the present stage, to derive from the data in the table any parameters that could be of subsequent use.

Nevertheless, the available evidence suggests that, in the case of programmed instruction as in the case of other technologies, the scale of the technical resources employed warrants an economic approach based on such traditional concepts as the combination of factors, economies of scale, and so on. This will be one of the purposes of the next section, which may help to introduce some new elements into a field where there would seem to be no means available for comparing the costs of programmed learning with its benefits.

3 Cost analysis

3.1 *The time devoted to a programme*

This section deals with the time spent on the production, reproduction, distribution and promotion of a thirty-two-hour mathematics course.

TABLE 28. Production of mathematics sequences 1–15 (in hours)

Participants	Stage					Total
	Preparation	Production	Supervision	Revision	Production II	
Consultants	25	80	40	—	25	170
Unesco expert	5	20	10	—	5	40
ENSAC expert	10	100	—	—	—	110
National trainees	30	550	100	55	—	735
TOTAL	70	750	150	55	30	1,055

TABLE 29. Production of mathematics sequences 16–32 (in hours)

Participants	Stage					Total
	Production	Supervision	Production II	Supervision II	Production III	
Scientific adviser	—	51	—	45	—	96
Unesco expert	136	—	51	—	15	202
National teachers	136	—	—	—	15	151
Teacher (French Co-operation Service)	119	—	51	—	15	185
ENSAC expert	34	—	51	—	—	85
TOTAL	425	51	153	45	45	719

TABLE 30. Final production of thirty-two mathematics sequences (in hours)

Participants	Stage			Total
	Validation	Supervision	Production	
Scientific adviser	—	32	—	32
Unesco expert	—	—	32	32
National teachers	54	—	32	86
Teacher (French Co-operation Service)	54	—	32	86
TOTAL	108	32	96	236

It was out of the question to base the calculations on the regular working hours of the officials involved in the various operations, since these did not correspond to the actual time devoted to these operations. In considering what is said below regarding the bases used for the calculations, it should accordingly be borne in mind that these relate to the actual (productive) hours worked.

3.1.1 *Production times*

For the first phase of production, times were calculated on the basis of estimates by J. Pocztar who had been in charge of the 'factory course' in 1969. These times are shown in Table 28.

Production times for the second and third phases of production were calculated on the basis of data supplied on the spot by the counterpart of the Unesco expert, who is now the national official in charge of the programmed-instruction section of the Ministry of National Education. This official took part in all phases of the project; he took notes and, generally speaking, kept 'accounts' of the various production stages, and these were accurate enough to make an estimate of the time devoted by each participant to production. These times are recorded in Tables 29 and 30.

Observation No. 1. The tables do not take account of manpower units collaborating in the work. It was decided that such information had no decisive influence on the cost calculations presented in this study. However, if a large-scale programme were set in motion, this element would obviously be relevant to the planning of the various tasks.

A manpower breakdown for the various phases is given below for information purposes:

Phase A: Course: 122 man-days divided among the Unesco expert, three consultants and a Unesco Headquarters official, together with occasional assistance from Unesco experts teaching at ENSAC (Brazzaville). Finally, twenty-nine trainees participated for a period of sixteen days, and ten for a period of fourteen days.

Phases B and C: A Unesco expert, three Congolese lower-secondary teachers (one being the expert's counterpart), a teacher from the

Table 31. Time taken to duplicate programmed instruction sequences

Task	Work units			Premises	Time per unit of material
	Staff	Material	Machinery and type		
Typing	1	1 stencil	1 mechanical typewriter	Expert's office	30 min.
Drawing, symbols, checking	1	1 stencil	—	Expert's office	20 min.
Printing					
Fixed time	1	1 stencil	Electric copier	Room at ENSAC	4 min. (fitting of stencil and trial)
Variable time	1	100 p.	Electric copier	Room at ENSAC	82 sec/100 p.
Trimming	1	800 sheets	1 trimming machine	Literacy Centre	40 sec for 3 cuts
Stapling	12	1 booklet	2 mechanical staplers	Expert's office	55 sec

French Co-operation Service and a Unesco expert teaching at ENSAC.

Observation No. 2. There is a considerable difference in the total time devoted to the first and second phases, the first producing a unit time per sequence of 70.3 hours and the second 42.3 hours. The reason is that production was less efficient during the first phase because of the presence of trainees. On the other hand, looking at the operation as a whole, it will be seen that the first phase produced also provided thirty teacher-trainees with training in PI, a not unimportant factor in the process of introducing this technology.

3.1.2 *Reproduction times and materials required*

The *reproduction time* for the sequences was calculated on the basis of an analysis of the different tasks[1] involved in duplicating the sequences for the three experimental phases. The times are therefore specific to this experiment. This is specially important for the time spent on duplication, which could be improved by making more intensive use of plant (a faster copying machine or offset). It should, however, be noted that the transfer to reproduction techniques involving more advanced

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[1] This analysis was made with the help of the head of the PI section and, for the duplication process, with the head of the printing service of ENSAC, which between 1969 and 1972 published all the sequences described here.

TABLE 32. Reproduction times for fifteen sequences of 500 copies each and materials required (in hours and specified quantities)

	Preparation		Printing (duplication) time			Finishing	
	Typing	Drawing, symbols, checking	Fixed	Variable	Total	Trimming	Stapling
Machine-hours	67.5	—	9	15.5	24.5	0.5	—
Man-hours	67.5	45 (Unesco) 45 (trainees)	9	15.5	24.5	0.75	115 (trainees)
Materials (in specified quantities)	135 stencils (+ 15 spoiled) = 150	—	—	37,500 sheets (+ wastage) = 41 reams of paper		—	1,500 staples
Premises (in hours)	67.5	45	9	15.5	24.5	0.5	10
Electricity (in kWh)	—	—	2.7	4.7	5.4	3	—

machinery may entail longer preparation times. The basis of calculation is shown in Table 31.

The *quantity of material* needed for the printing of one thirty-two-page booklet containing a one-hour course is as follows: five sheets of 19 × 33 cm, 80 g/m^2 paper (four printed on both sides plus one test sheet); nine stencils per sequence regardless of the number of copies (eight for content, one for the test sheet); printing ink—estimated at 0.3 g per m^2 of paper; staples—two per booklet.

Observation No. 1. The times indicated do not include the transport of materials from one place to another (apart from the trimming machine which was in a different building). These times seemed too insignificant to be taken into account; however, they would have to be considered in a larger operation.

Observation No. 2. The time for 'drawing and symbols' varies according to subject.

Observation No. 3. The stapling team consisted of an official, a secretary and ten pupils (unpaid) for phases B and C. The cost calculation therefore includes only the salary of the official and the secretary. For phase A, the work was done by the trainees and the Unesco experts.

Tables 32, 33 and 34 indicate the time and materials needed to reproduce the sequences for the three phases: 500 copies for phases A and [illegible], 1,200 for phase C.

3.1.3 *Distribution times*

The distribution times for the 500-copy experiment were not estimated, since it took place in three general lower-secondary schools in Brazzaville.

TABLE 33. Reproduction of seventeen sequences of 500 copies each (in hours and specified quantities)

	Preparation		Printing (duplication) time			Finishing	
	Typing	Drawing, symbols, checking	Fixed	Variable	Total	Trimming	Stapling
Machine-hours	76.5	—	10	17.5	27.5	0.5	—
Man-hours	76.5	51	10	17.5	27.5	0.75	130
Materials	170 stencils	—	—	47 reams of paper 1.3 kg. of ink		—	1,700 staples
Premises (in hours)	76.5	51	10	17.5	27.5	0.5	11
Electricity (in kWh)	—	—	3	5.3	8.3	3	—

TABLE 34. Reproduction of thirty-two sequences of 1,200 copies each

	Preparation		Printiug (duplication) time			Finishing	
	Typing	Drawing, symbols, checking	Fixed	Variable	Total	Trimming	Stapling
Machine-hours	144	—	19	79.2	98.2	2.2	—
Man-hours	144	96	19	79.2	98.2	2.7	586
Materials	310 stencils	—		211 reams (1,000 sheets) 6.5 kg. of ink		—	7,000 staples
Premises (in hours)	14	—	19	79.2	98.2	2.2	49
Electricity (in kWh)	—	—	5.7	23.8	29.5	5.5	—

The distribution times for the third phase—prior to general introduction of the thirty-two mathematics sequences—were taken into account, since the counterpart himself distributed the sequences among various up-country general lower-secondary schools.[1] The vagaries of traditional methods of distribution were thus responsible for a total of thirty days on mission. Incidentally, this illustrates one of the major material problems encountered when planning to set in motion a programmed-instruction course.

[1] Pointe Noire, Minduli, Dolisie, Mvuti, Jacob, Madingu, Sibiti, Fort Rousset, Ouesso, Imfomo.

TABLE 35. Radio and television broadcasts produced to promote PI

Year	Type	Duration (minutes)	Number	Total number of hours	
				Radio	Television
1969–70	Radio	30	3	1½	
1970–71	Radio	30	1	½	
	Television	45	1		¾
1971–72	Radio	30	3	1½	
1972–73	Radio	30	4	2	
1973–74	Radio	30	3	1½	
	Television	50	2		1¾
TOTAL			17	7	2½

3.1.4 *Time devoted to promotion*

Table 35 indicates the broadcasts made by the expert's counterpart. It should also be noted that the Unesco expert took a special interest in this matter, and it is no doubt thanks to him that the People's Republic of the Congo is now so receptive to this educational technology. However, it did not prove possible to calculate the time per expert devoted to this activity.[1]

3.2 *The costs of a programme*

The following paragraphs contain an estimate of the costs of each operation (production, reproduction, distribution), dealing separately in each case with labour costs, machine costs, a share in recurrent costs and, where appropriate, the costs of materials.

3.2.1 *Production costs*

1. *Labour costs per hour.* These costs were estimated as follows: (a) annual salaries (including social-security costs but not family allowances) for staff belonging to the administration of the People's Republic of the Congo; (b) fees (per diem and travel expenses) for consultants (however, travel expenses have been shown separately in the tables in order to make allowance for their *ad hoc* nature); (c) salary and other expenses for the Unesco expert.

Moreover, the basis for calculating costs per hour was determined after deducting leave time and public holidays from working hours. Similarly, for the production and supervision phase, it was assumed that time could not be translated into actual costs without taking into account the fact that, in the long run, real productive time is less than average working time. The various parallel tasks which are not directly linked to the preparation of sequences were estimated at 25 per cent of the time of service used to calculate the cost per hour.

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[1] Special mention should be made of the fact that PI has formed part of the teacher-training curriculum for student teachers at ENSAC since 1968.

Thus it will be seen that an element additional to the explicit cost of production is introduced, namely the implicit cost of the various activities which accompany the production and supervision of sequences, but whose contribution, from a strictly production standpoint, cannot be taken into account.

The Unesco expert. The expert's hourly salary is based on average Unesco payments for 1969 and 1970, as they appear in the Unesco accounts. This average includes the travel expenses paid by Unesco at the end of a two-year field appointment. The years 1971 and 1972 have not been taken into consideration, since the accounts published by UNDP, the agency sponsoring the project during this period, no longer include net salary but only a standard salary.

Calculating base: $25,200 per year (46 weeks' work at 40 hours per week); 1,380 hours spent on 'production and supervision'. Cost per hour: $18.26.

National teachers. These consist of young teachers in category A.II and at the second step of the social-services scale, earning a salary of 1,013,555 C.F.A. Francs per year (including retirement contributions but not family allowances), i.e. $3,645.

The actual time devoted to production and supervision was estimated on the following basis: leave, fifteen weeks; public holidays, half a week; weekly working time: twenty-four classroom hours, plus sixteen hours for marking and preparation.

Allowing for the 25 per cent deduction referred to above, this makes an annual total of 1,095 hours.[1]

Unesco teacher-experts from ENSAC. Costs are identical with those of the project expert, since the contracts of these teachers cover activities other than teaching (for example, the training of counterparts). It might also be mentioned, in passing, that the annual cost as estimated above for the project expert, i.e. $25,000, is also roughly equal to the average cost used at that time for project evaluation purposes. In the absence of other data, we have therefore taken it as our basis. Cost per hour: $18.26.

Teachers supplied by the French Co-operation Service. Having no figures for the average cost of such teachers and considering that their participation in the programme was fairly limited, we have arbitrarily taken their cost as $15,000, i.e. 4,165,000 C.F.A. Francs, including the contribution by the Government of the People's Republic of the Congo of 480,000 C.F.A. Francs (subsistence allowance) and 420,000 C.F.A. Francs (housing allowance).

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[1] It is interesting to note that in J. Vaizey *et al.*, *The Costs of New Educational Technologies* (Lisbon, Centro de Economia e Finanças, 1971) the conclusion is reached that in the United Kingdom, a teacher makes an annual contribution of 1,200 hours to his school at a total cost of £1,468. Nevertheless, as Vaizey points out, a teacher is unable to produce and revise a large quantity of programmed-instruction material without interruption. Vaizey therefore increases the annual cost of the teacher by 9 per cent, which is equivalent to reducing his actual productive time to 1,092 hours per year, a figure very close to our own.

The annual hourly total was calculated on the same basis as for national teachers, namely 1,095 hours. Cost per hour: $13.69.

Supervision costs.[1] The supervision was carried out by the course consultants during the first phase; the costs are therefore evaluated on the basis adopted for the course (see below).

On the other hand, during the second and third phases, supervision was provided by the St Cloud Senior Teacher Training College. Up to May 1971, daily consultant fees, without travel, were $63, that is an hourly cost of $7.875.[2]

Course costs. This phase is taken separately from the other two, since it witnessed a period of intense production for which detailed figures are available:

Consultants: fees and per diem for four consultants, for a period of ninety days, $6,989.60; travel costs for four consultants (source: Unesco accounts), $3,684.00; total working time, 692 hours;[3] real cost per hour, $10.10 (fees), $5.30 (travel).

Expert: cost for 32 days or 4.57 weeks (on an annual basis of $25,000), $2,500; working time, 177 hours;[3] real cost per hour, $14.10.

Trainees: The hourly cost of trainees is the sum total of the following elements:

The cost to the government, i.e. the economic cost per hour of a lower-secondary teacher, at the first step of the social-services scale, calculated on the basis of 917,500 C.F.A. Francs per year (or $3,303). In all, twenty-nine trainees, earning on average the above annual salary, attended the course for sixteen days, and

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1. This refers to the scientific, or more accurately the didactic, supervision of sequences.
2. Source: Bureau of Personnel, Unesco.
3. As estimated by the course director, the time devoted to production (in hours) was as follows:

Subject	Maths (bottom lower-secondary) (15 sequences)	Science (13 sequences)	Geography (8 sequences)	Grammar (18 sequences)	Total
Consultants	200	200	93	200	692
Expert	50	50	27	50	177
Trainees	830	520	390	870	2,610

Taking into consideration the fact that the purpose of the course was production and applying the same costing principle, we have therefore included the total cost of consultants under production.

Table 36. Production costs (manpower) of mathematics sequences 1–15 (bottom lower-secondary) (in United States dollars)

Participants	Stage					Total
	Preparation	Production	Supervision	Revision	Production II	
Consultants (including travel)	385.50 133	1,233.60 425.60	622.80 218.80	—	308.40 106.40	2,550.30 833.80
Unesco expert	70.70	282.80	141.40	—	70.70	565.60
Teacher expert (ENSAC)	182.6	182.6	—	—	—	2,008.60
Trainees	137.4	251.8	459	251.9		3,366.30
Total	776.2	5,861.4	1,222.2	251.9	379.10	8,490.8

Table 37. Production costs (manpower) of mathematics sequences 16–32 (bottom lower-secondary) (in United States dollars)

Participants	Stage					Total
	Production	Supervision	Production II	Supervision II	Production III	
Scientific adviser	—	401.88	—	354.60	—	756.48
Unesco expert	2,483.36	—	931.26	—	273.90	3,688.52
National teachers	452.88	—	—	—	49.95	502.83
Teachers (French Co-operation Service)	1,629.11	—	698.19	—	205.35	2,532.65
Teacher expert (ENSAC)	620.84	—	931.26	—	—	1,552.10
Total	5,186.19	401.88	2,560.71	354.60	529.20	9,032.58

ten trainees for fourteen additional days: a total of 604 man-days (including Saturdays and Sundays);

Since a teacher is on duty 36.5 weeks per year (see above), i.e. 255 days, the total economic cost of the course to the government is $7,824 and the hourly economic cost per trainee is $3 (calculated on the basis of 2,610 hours which represents the total hours of service supplied by trainees, as indicated in the footnote on page 143;

The total cost to Unesco, consisting of per diem and travel expenses to a total of $4,118: cost per hour: $1.58. The total cost per hour of trainees is therefore: $4.58.

Tables 36, 37 and 38 show the production costs, in terms of manpower, of the first, second and third phases as described above.

TABLE 38. Final production costs for thirty-two sequences (bottom lower-secondary) (in United States dollars)

Participants	Stage			Total
	Validation	Supervision	Production	
Scientific adviser	—	252.16	—	252.16
Unesco expert	—	—	584.32	584.32
National teachers	179.82	—	106.56	286.38
Teachers (French Co-operation Service)	739.26	—	438.08	1,177.34
TOTAL	919.08	252.16	1,128.96	2,300.20

2. *Capital production costs.* Capital costs cover only the use of premises during the production of sequences, since no heavy equipment was necessary at this stage. These premises were in the buildings of ENSAC, where the project expert had an office and the use of a meeting room.

Although the depreciation cost shown here may seem minor, we felt it should be included in the study because it represents an important cost factor in larger operations. This also applies to current maintenance costs, and so on.

The basis used for calculation is the cost per square metre of the ENSAC premises, estimated at 91,500 C.F.A. Francs[1] (excluding construction and equipment costs). This sum represents the original cost of construction which began in June 1966 and was completed two years later. By and large, this may be regarded, between the years 1969 and 1972, as a replacement cost—which obviates the need to consider the problem of major repairs, etc.

In the calculations which follow, the cost per square metre is amortized over thirty years,[2] at a social interest rate of 5 per cent, a figure often used for government investment when more accurate data are not available.

The use of an interest rate to calculate an annual figure representing the amount payable as interest and the repayment of principal on a loan equal to the investment cost, over a specific period, has already been exhaustively discussed in the literature. On the one hand, capital expenditure out of public funds may be regarded as not entailing implicit interest rates; in other words, as being outside the commercial circuit and thus incapable of furnishing a finished product cost which would include depreciation. On the other hand, it cannot be denied that resources are, by economic definition, scarce, particularly in developing countries. This being so, it is legitimate to calculate depreciation on the basis of an interest rate, especially in view of the fact that in Third World countries part of educational investment originates in loans. In either case, it seems useful to include an entry representing the utilization cost of capital resources which could have been used for other purposes. Moreover, depreciation calculated at a constant yearly rate makes it possible to include this amount in recurrent expenditures, in the same way as operating costs.

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[1] The total cost calculated in 1971 for the evaluation report (R/UNESCO/PNUD/SF.CON (B)9) amounts to 352 million C.F.A. Francs. The total surface area of ENSAC is 3,845 square metres. It was not possible to produce separate figures for the restaurant (473.2 square metres) or for the living accommodation (900 square metres). However, in the opinion of the Chief Project Advisor, the modular construction of the group of buildings results in costs being practically identical, regardless of what the space is used for.

[2] According to the planning service of the national education system, this period should be twenty years in the case of general lower-secondary schools, mainly because of the very damp climate. In view of the difference in construction costs for these and ENSAC classrooms, which is of the order of 300 per cent, a basis of thirty years was chosen.

Phase A. (a) production time is known—32 days (or 4.57 weeks); (b) premises—four classrooms consisting of three modular units, the expert's office and a meeting room, used for 25 per cent of the total utilization time (as estimated by the chief ENSAC adviser), amounting to a total surface area of 320.4 square metres (source: ENSAC plans); (c) construction cost of this area—29,316,600 C.F.A. Francs or $105,540; (d) annual depreciation cost—$6,865 (to be spread over forty-six weeks); (e) share to be charged to the course—$682 (to be spread over a production of fifty-four sequences); (f) share to be charged to fifteen mathematics sequences—$190.

Phases B and C. The time base for the use of premises is difficult to estimate in this instance. Production in phases B and C took place over two years (1970–71) in the premises placed at the disposal of the expert. The problem is to reckon that part of the annual depreciation cost which should go to cover use of the premises for production of the sequences in question.

In view of the fact that sixty-two sequences were prepared and thirty-two sequences produced in final form during the 1970–71 period, the following arbitrary working hypotheses were adopted: (a) mean production time for one sequence—36.6 hours (source: Table 29) from which ninety-six hours of supervision abroad were deducted); (b) total production time for sixty-two sequences—2,270 hours; (c) total production time for thirty-two sequences in final form—236 hours (source: Table 30); (d) seventeen sequences, phase B (or 630 hours) representing 25.5 per cent of the time the premises were occupied for the production of the mathematics sequences, and thirty-two final sequences representing 8.2 per cent of this time; (e) area of premises placed at the expert's disposal—102 square metres; (f) annual depreciation cost for this area—$2,185; (g) annual depreciation cost charged to phase B—$557; (h) annual depreciation cost charged to phase C—$179.

TABLE 39. Salaries of Congolese administration staff

Worker	Annual salary in C.F.A. Francs	Hourly salary	
		C.F.A. Francs	U.S.$
Printer	428,446	244	0.878
Printing worker	336,515	191	0.688
Photographer	1,317,350	749	2.696
Photo-engraving worker	336,515	191	0.688
Folding specialist	428,446	244	0.878
Folding worker	336,515	191	0.688
Trimmer	361,890	206	0.742
Insetter	318,890	181	0.652
Binder	336,515	191	0.688
Duplicator operator	318,120	181	0.652
Typist	361,890	206	0.742
Labourer	291,880	166	0.598

These amounts are shown in the general summary table.

3. *Recurrent costs for production.* Once again it is very difficult to calculate the recurrent costs relating to a period of activity for which no precise data are available. While the ENSAC budget of recurrent costs for 1971 was, of course, available, it did not prove possible to produce a breakdown by service, much less by group of activities relating to PI.

3.2.2 *Reproduction costs*

1. *Labour costs per hour.* The approach is identical to that adopted in the previous section. We shall therefore not recapitulate.

The basis for calculating hourly costs for administration and services is as follows: leave, six and a half weeks; public holidays, one and a half weeks; hours per week, forty; total hours per year during which services are actually rendered: 1,760.

Table 39 indicates the salaries for administration staff who took part in the work of reproduction.

The figures include employer and employee contributions to social security and pension funds. Family allowances are not included, having no relation to the work carried out. The salaries given are not average figures since, after consulting the State Publishing House budget for 1972 and the ENSAC budget for 1971, we were able in most cases to relate the jobs and workers concerned. While the available documents only partly cover the period under consideration, this is of little importance since the salary and wages scale for administrative personnel in the People's Republic of the Congo has not been changed for several years.

Hourly salaries were used to calculate the cost of reproducing the sequences, as shown in Tables 40, 41 and 42 below.

TABLE 40. Reproduction costs for fifteen sequences of 500 copies each (in United States dollars)

	Preparation		Printing (duplication) time			Finishing	
	Typing	Drawings, symbols, checking	Fixed	Variable	Total	Trimming (variable)	Stapling (variable)
Machines	2.5	—	1.3	2.2	3.5	0.20	—
Labour	50	544	6	10	16	0.75	0.526
Materials	65 (stencils)	—	paper: 130 ink: 12.4		142.4	—	4.30
Depreciation of premises	16.2	26.6	1.9	3.2	5.1	—	6.4
Electricity	—	—	0.2	0.3	0.5	0.2	—

TABLE 41. Reproduction costs for seventeen sequences of 500 copies each (in United States dollars)

	Preparation		Printing (duplication) time			Finishing	
	Typing	Drawings, symbols, checking	Fixed	Variable	Total	Trimming (variable)	Stapling (variable)
Machines	3.0	—	1.4	2.5	3.9	0.20	—
Labour	56.8	169.8	6.6	11.4	18.0	0.75	45
Materials	73 (stencils)	—	paper: [illegible]49 ink: 1[illegible].3		162.3	—	5.00
Depreciation of premises	18.4	30.1	2.1	3.7	5.8	—	7.0
Electricity	—	—	0.2	0.3	0.5	0.2	—

2. *Cost per hour of machines*. The same approach is adopted as for the depreciation of buildings. A linear annual depreciation cost is calculated on the basis of the 1970 replacement cost of the equipment and its economic life. The economic life is, of course, shorter than the actual life, but this may be disregarded on the grounds that breakdown risks and maintenance costs make it counter-productive to continue using such equipment.[1] Nor has account been taken of the end value of equip-

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[1] Our working hypotheses also make it possible to compare these data with those of private companies manufacturing PI programmes. Such companies are obliged to take into account implicit payments for production factors which might have been put to other uses. Finally, economic amortization makes it possible to suggest an approximate method for solving, to some extent, the problem set by the low productivity of plant in the majority of public bodies, where the very concept of the economic profitability of investment is not taken into consideration. If, for instance, the Literacy Centre trimmer, here depreciated over ten years, has in fact been in operation for more than twenty years, at about 25 or 30 per cent of its productive capacity, it seems likely that its under-utilization is the reason for a working life that exceeds economic expectations.

TABLE 42. Reproduction costs for thirty-two sequences of 1,200 copies each (in United States dollars)

	Preparation		Printing (duplication) time			Finishing	
	Typing	Drawings, symbols, checking	Fixed	Variable	Total	Trimming (variable)	Stapling (variable)
Machines	5.5	—	3.7	11.2	13.9	0.90	—
Labour	106.8	319.75	12.6	51.6	64.2	2	2.00
Materials	134 (stencils)	—	paper: 668 ink: 61.9		729.8	—	22
Depreciation of premises	34.6	56.6	4	16.6	20.6	—	31.4
Electricity	—	—	0.3	1.4	1.7	0.3	—

ment, on the grounds that technological progress very quickly makes it obsolete.[1] Lacking other data, we have again applied an interest rate of 5 per cent.

Geha duplicator (ENSAC). (1970 price.) Economic amortization over five years. Tax-free price, including transport: 300,000 C.F.A. Francs. Annual depreciation cost: 69,500 C.F.A. Francs to be spread over forty-four weeks of forty hours, i.e. an hourly depreciation cost of 39.50 C.F.A. Francs or $0.142.

Herold trimmer (Literacy Centre). Economic amortization over ten years. Tax-free price, including transport, in 1970: 1,800,000 C.F.A. Francs. Annual depreciation cost: 234,000 C.F.A. Francs to be spread over fifty-two weeks of forty hours, i.e. an hourly cost of 112.50 C.F.A. Francs or $0.405.

Olympia mechanical typewriter. Economic amortization over ten years. Tax-free price, including transport: 75,000 C.F.A. Francs. Annual depreciation cost: 9,712 C.F.A. Francs to be spread over forty-six weeks of forty hours, i.e. 5.25 C.F.A. Francs or $0.02.

3. *Costs of material (1969–70 prices):* Stencils, unit price at Brazzaville, 120 C.F.A. Francs or $0.432; duplicator paper, f.o.b. Paris price equivalent to 315 C.F.A. Francs for a 500-page ream; transport Paris–Brazzaville—on the basis of a shipment made at the end of 1970, by Unesco, of 10.3 tons of paper (including 297 reams of 500 sheets, weighing 802 kg), the cost of which was estimated at $1,772, we estimate a total transport cost of $134 for paper, which produced a unit cost of $0.45 and hence the cost of a 500-page ream c.i.f. Brazzaville of $1.58; ink, 2,650 C.F.A. Francs per kilo, i.e. $9.50; staples, 80 C.F.A. Francs per thousand, i.e. $0.30.

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[1] Here, as in other cases, we decided to err on the safe side since our primary aim is to determine the maximum cost of PI in order to bring out subsequently the economic implications of its use at a later stage.

4. *Recurrent costs.* Since the reproduction time for the operation described in these pages is not long enough to warrant calculating a share in ENSAC recurrent costs, we merely entered electric-power costs for the duplicators (0.3 kWh) and the trimmer (5 kWh), the latter consuming electricity for only 50 per cent of the operation time. The cost per kWh in Brazzaville is 16 C.F.A. Francs.

5. *Hourly depreciation cost of premises.* This was calculated on the same basis as for the production period (see above). Once again, these costs are mentioned for the record, since their impact on total costs is negligible. Nevertheless, in a larger operation, such costs have to be taken into account, and this is why they are shown in the tables.

Surface area and occupation rate of premises were broken down as follows:

Typing: expert's room, 81.6 square metres and 25 per cent occupation rate.
Checking, drawings and symbols: expert's room and meeting room, equivalent to 102 square metres and 50 per cent occupation rate.
Duplication: ENSAC duplicating room, 1 modular unit, 18.2 square metres and 100 per cent occupation rate.
Trimmer: no data available.
Stapling: one classroom, 54.5 square metres for one-half of the total stapling time.

The annual depreciation cost has to be spread over forty-six weeks, assuming the premises to be used forty hours a week. The hourly depreciation rate for the various premises is as follows: typing, 66 C.F.A. Francs or $0.24; checking, drawings and symbols, 165 C.F.A. Francs of $0.59; duplication, 59 C.F.A. Francs or $0.21; stapling, 177 C.F.A. Francs or $0.64.

3.2.3 *Distribution costs* (see observations on distribution times, above)
Air and rail costs, 118,700 C.F.A. Francs; salary (one teacher, one month), 84,450; mission expenses (one month), 41,600; Total, 244,750 C.F.A. Francs.

3.2.4 *Introduction costs*

These are not taken into consideration. The cost of the test sheets was calculated together with the cost of reproducing the sequences, since they related to an experiment with a specific group. Staff costs, too, are omitted, since the teachers themselves were responsible for introducing the courses in their own classes. An economic cost might conceivably be taken into account but, in our view, this would be justified only if the project went into general use with a modification of the actual classroom structures, both with regard to the distribution of teaching staff and the size of classes.

3.2.5 *Promotion costs*

The cost of radio and television broadcasting, as recorded in Table 35, can be estimated on the basis of the following figures:

Radio hour, including staff costs, minor equipment and miscellaneous costs (electricity, etc.) but excluding depreciation on broadcasting equipment: $29.95.

Television hour, on the same basis: $180.

Total cost: radio, $205; television, $405.

These figures are not included in the general table because, first, it is impossible to produce a more precise distribution of costs by type of production and, second, the time per expert devoted to this work cannot be estimated.

Conclusion

This study is more concerned with methodology than with raw facts. in the case we have examined, it is true that the data were difficult to collate and that calculations had to be made in order to establish, for instance, the costs per hour of the different categories of personnel involved in the project. It seems likely that in many cases these costs will already have been worked out, which will reduce the amount of calculation to be done. We were therefore faced with the most complicated case, which may be of interest to the extent that in other cases there are sure to be fewer problems. The case study shows what should be looked for, and how to do it, in order to arrive at valid cost estimates.

The costs of programmed instruction: conclusions drawn from an investigation[1]

1. General considerations as to method

1.1 *The level of analysis*

A double aura of uncertainty surrounds both the theory and the practice of programmed instruction.

The investigation made it clear that the known experiments in programmed instruction (PI) were almost invariably a watered-down version of the theory or pedagogical ideal of PI; it showed that PI was often used as one of a number of elements in an educational programme; it also revealed that the majority of PI experiments used printed materials as the medium of instruction, despite the wide range of media theoretically possible. These various conclusions can be summed up by saying that it is difficult to continue to maintain that PI represents a highly specific form of educational method in practice.

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[1] Taken from a survey carried out for Unesco in 1975 by D. Millot, G. Nihan and B. Rasera of the Institute for Research into the Economics of Education (Dijon).

The second aspect about which there is uncertainty is the economic aspect, which merely reflects, however, the situation already referred to concerning the teaching aspect. In view of the large number of different forms taken by PI activities, it is scarcely realistic to regard PI as an activity which lends itself to a specific, standardized economic approach; this would be true only of forms of PI in which care was taken to preserve those characteristics that make PI an entire method of teaching on its own. Even in their debased form, however, the PI experiments examined require an economic approach which must be more than simply a transposition of the now well-known methods applied to non-programmed instruction, which will be referred to in this document as traditional instruction. It should be stated at once that the heterogeneous nature of PI for the purposes of economic analysis, apart from the various forms of the experiments themselves, is due largely to the fact that the execution of an entire PI process requires a succession of operations which cannot be reduced to a single formula: some of these operations are actually a form of industrial activity (reproduction of materials) whereas others represent a form of educational work on a small scale (conceiving specialized programmes). This second cause of diversity is the reason why, as will be seen, we have treated the subject in distinct phases.

An important point needs to be stressed right away concerning the level of economic analysis to which this work can lay claim. Indeed, in this respect, the reader should not be misled by the use of the term 'costs' in the title of this chapter; such a term does, in fact, carry a precise meaning within a specific analytic context. Let us develop this point further:

1. Cost is considered in relation to either separate or combined production factors or in relation to a well-defined product; in its present form, however, whether considered as an activity or as a product, PI is characterized first and foremost by its fluctuating boundaries and its variable content.
2. Cost is a measurement, and therefore an index, of relativity, expressing where one quantity stands in relation to another; as an aid to decision-making, cost must reflect the total quantity of resources extended on one activity rather than on another; cost is the price of the alternative,[1] and alternatives are numerous in an educational process which takes the form of a succession of phases that are interdependent but also capable of integration

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[1] By generalization of the opportunity principle.

with other parts of the process (*x*-type PI versus *y*-type PI; PI versus traditional instruction; PI versus other services). Analysis is made particularly difficult in this respect by the fact that economic agents with extremely different responsibility levels are to be found side by side.[1]

3. One of the main functions of cost should be to act, in conjunction with effectiveness, as an instrument of comparison—assuming that the problems of defining PI's results and objectives, not to speak of the benefits it brings, have been resolved; since its benefits and output have not been systematically evaluated together, costs cannot in this case be expected to serve as an instrument of comparison except for the purpose of setting them directly against the total volume of available resources, which, of course, is essential in certain cases.
4. Finally, in view of the variety of economic agents involved in PI activities, there is no possibility of calculating an anonymous, 'all agents' cost which would disregard the respective roles of the various agents responsible and the distortions these introduce into cost figures.

The authors have therefore adopted a less normative frame of reference: that of direct costs or, in other words, expenses. The data needed by the planner to translate these direct costs into real costs are peculiar not to PI but to the more general system of instruction with which the planner is familiar and for which he is responsible. In other words, this report will be found to contain an evaluation of the costs which the economic agents involved in programme implementation have actually had to bear, to the extent to which these costs represent monetary expenditure flows. These evaluations therefore exclude expenses represented by the use of resources not specifically allocated to PI but necessary for all other forms of instruction (student time, buildings, overheads); in this respect, the financing of these resources constitutes an indirect expense as far as the selected level of internationalization is concerned.

1.2 *Utilization of the data*

In order to show more clearly which direct costs are concerned and how they have been calculated, reference must be made to the basic statistical data, since, at this level, it is they which directly affect the choice of evaluation method.

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[1] This co-existence of payers and deciders at different responsibility levels makes it more difficult, in fact, to select an internalization level which is valid for a large number of experiments.

1.2.1 *The level of evaluation*

The data collected in the course of the investigations concern an extremely wide range of PI experiments carried out in some ten different countries. Twenty-nine experiments in all have been used for the purpose of calculating costs. The numbers involved and the degree of diversity (which reflects the diversity found in practice) obviously do not allow a true international comparison to be made nor a methodical comparison between media. In any case, totalling up these experiments and calculating the general average cost would have no statistical meaning, nor theoretical value, and would therefore be useless for planning purposes to the decision-makers, be they local, national or international. At the other extreme, a strict case-by-case study, however valuable it may be in other circumstances, is not applicable to an investigation carried out by questionnaire and requires close and thorough observation carried out on the actual site of the experiment.[1]

On the other hand, the information contained in the questionnaires, as well as the size of the sample,[2] provides material for statistical processing which gives an estimate of costs for characteristic groups of experiments representing different types of PI. The method of arriving at these estimates is similar to that used in the pedagogical context but necessarily gives different results, especially as the limitations imposed by the size of the sample mean that the tree of alternatives offers only a small number of terminal branches. The criteria taken into account in determining *a priori* types of PI were as follows:

1. Economic and legal status of the establishment carrying out the instruction. The only factors that are relevant in this connexion are those which result in economic attitudes differing from one institution to another (management principles, degree of competitiveness, extent to which subsidized, etc.). For example, a distinction can be made between private and public enterprises, or between profit-making and non-profiting-making enterprises. The nature of the institution's main activity is also taken into consideration, but in this respect only two categories are relevant to this survey: educational activities and others.
2. The population for whom the programme is intended. This is not a matter of the different 'demographic' characteristics of the students, but of the 'closeness of their connexion' with the institution providing the PI; a distinction is made, in other words, between

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[1] J. Pocztar and G. Nihan, *Les Coûts d'un Cours d'Enseignement programmé en Mathématiques modernes : l'Expérience d'Afrique Centrale*, Paris, Unesco, 1974.

[2] A sample whose representative character does not, in statistical terms, need to be justified or, rather, for which there is no call to deplore the unrepresentative character. Indeed, representativeness would be difficult to achieve in that it is not really known who carries out what programmed instruction (at least in countries where there is no central authority).

an 'internal' population (i.e. internal to the institution) and an 'external' population.[1]

3. Finally, the type of material used as the medium of instruction clearly constitutes a third differentiating factor, over and above the two previous criteria. The media used in the sample were simply divided into printed media on the one hand and non-printed media on the other. The second category covers the use of computer, film, slides or tape recorder by themselves and the use of multimedia techniques.

Simultaneous consideration of the three criteria leads both to cross-tabulations which give rise to new criteria and to the elimination of combinations which, in view of the composition of the sample or merely of economic logic, are merely 'dead branches' in the tree of alternatives; this tree finally appears as shown in Figure 4.

Disregarding the medium of instruction, the experiments fall into groups as follows: 1 (educational) as opposed to 2, 3, 4 (non-educational); 1, 2 (non-profit-making) as opposed to 3, 4 (profit-making); 1, 2, 3 (internal students) as opposed to 4 (external students).

It will be noted that the private/public criterion does not explicitly appear in the final tree since it is already covered in fact by the other criteria. Public educational establishments thus fall into group 1 and administrative departments into group 2. It will be noted, in this connexion, that university students and school pupils have been treated as internal populations in relation to their universities and schools in the same way as the employees of enterprises (as far as the production function is concerned). Similarly, activities placed in the fourth group are those where the PI represents one of a number of products manufactured by an establishment and sold by it to another establishment, whereas groups 2 and 3 contain institutions (which are mainly public in group 2 and private in group 3) which make use of PI for training their own staff. This simple tree of PI types (with eight final terms) thus makes it possible to use assessment methods suited to the type of experiment under consideration and to interpret the results on a differential basis as recommended by the Unesco working group on educational technology.[2]

1.2.2 *Types of costs*

The same group gave lengthy consideration to the question which type of costs it was most desirable (or most urgent) to study and calculate.

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[1] The educational level of the group concerned will be brought in subsequently, along with the variables which affect the scatter of the results (see Section 2). This factor does not in fact belong among the criteria relating to types of PI, which are defined in advance, and it was considered more useful to analyse it in the same way as the various explanatory variables.

[2] J. C. Eicher, *Cost Effectiveness Studies Applied to the Use of New Educational Media: Methodological and Critical Introduction* (general report on the work of the working group on information exchange on technical and economic studies related to educational technology), Paris, Unesco, 1975.

Using a taxonomical method, the group differentiates between 'economic', 'technical' and 'financial' costs.[1] Realizing the difficulty of classifying economic costs ('fixed', 'invariable or 'variable'), the group suggests ignoring these and concentrating on the other two types. It also recommends the adoption of terms that are as universal as possible for use in the calculation of costs. The authors of the present report have therefore borne this recommendation in mind, and the implications of this will be indicated below.[2]

The arrangement of the questionnaires themselves makes it possible to analyse an entire PI process in the following phases: pre-production; production; promotion; reproduction; distribution; implementation.

Every complete PI sequence, in theory, passes through these successive technical phases which constitute a logical and continuous development. Calculating separate costs for each phase is justified, in our opinion, by the fact that the factors which determine costs are of a technical nature[3] and that they may in fact differ greatly from one phase to another. The main factors which cause costs to vary are, *a priori*, the size of the programme and the number of students.

Furthermore, within a programme's development there are interactions between phases, of course, but also a certain degree of autonomy; production costs, for example, exert only a very marginal influence on reproduction costs, while the latter do not directly affect implementation costs.

What is more, although production, reproduction and utilization constitute part of the functioning of PI, pre-production and promotion are in practice optional, which explains the scarcity of information concerning them.

These three considerations led us to concentrate our analysis on the production phase (which, with the exception of certain calculations, will include pre-production operations) and, to a lesser degree, on the reproduction phase; there is in fact little information available on the latter and it was not possible to carry out as detailed an analysis as that made of production. Finally, only a few sparse data are available concerning the other phases and it was not possible to base very significant evaluations on them. The lack of statistical data on these phases indicates that they are thought of, by most of those responsible, as being 'free', and this, of course, would result in costs being underestimated, at a higher level of internalization than that selected for this survey.

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[1] 'Accounting' costs were unanimously agreed to have little relevance from an analytic point of view.

[2] The first point to note concerning these classifications it that, from a theoretical point of view, there is no such thing as costs which are 'technical' or 'financial' in themselves and that true costs are not anonymous (see Section 1.1); by differentiating between financial and other costs, the group was therefore merely recognizing the fact that in any form of cost evaluation it is necessary to identify the source of the funds.

[3] Using the term broadly to include pedagogical costs.

Is it possible to total the costs for different phases? The same factors which cause costs to vary from one phase to another (number of students, length of programme) could enable technical costs to be totalled in the form of a plane in three-dimensional space (cost/number of students/size of programme). But this would need a far larger number of experiments than were available on the basis of the investigation[1] and it will therefore not be attempted since its result would be of little value.

Another decision which had to be taken in order to determine the type of costs to be evaluated concerns the definition of resources to be taken into account. In view of the data available and the approach adopted (partly as a result of these data), the calculations relate mainly to staff costs, the cost of materials, and equipment costs.

This sub-classification was made possible by the amount of detail in the questionnaires.

The questionnaires were also designed to furnish details of two other items of expenditure: overheads and the cost of buildings. Here again, as far as the latter are concerned, the available data conspire with considerations of logic to prevent the calculations from being based on anything more than arbitrary estimates; the fact that no cost is apparently incurred in respect of buildings that are used by turns for different purposes and are not specific to PI, being neither rented nor built for that purpose, is certainly worth emphasizing, but assessment of the true cost can properly be made only at national level and by authorities possessing accurate information on the alternative uses to which such premises are put.

Speaking generally, a point which needs to be made is that, in the majority of cases where absence of data indicates that those responsible consider resources to be free, it may be inferred that the resources in question are used for more than one purpose and that, as far as those people are concerned and in a strictly educational context, PI entails no specific expenditure.

In the absence of fuller information, the same would seem to apply to overheads and pupils' time.[2]

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1. Quite apart from the difficulty created by the diversity of the operations performed (see Section 1.1).
2. Whether school-age or adult students. In any case, the cost of working time lost is not known. Information concerning this item would certainly be very interesting since as R. L. Brennan draws to our attention ('A Model for the Use of Achievement Data and Time Data in an Instructional System', *Instructional Science* (Amsterdam), Vol. 4, No. 2, 1955), students represent a major element in programmed instruction, in other words, in any educational process, student time also constitutes an expensive item, the cost of which varies according to the educational method used. It appears to be accepted that less student time is needed to learn a given subject than with traditional instruction. On this subject, see D. Rogers and D. Jamison, 'Economic and Educational Technology in the

1.2.3 *Units of cost*

The choice of units to be adopted for assessment of the costs of an educational technology will depend on the technology in question just as it depends on the phases of the teaching process itself. The problem of units of cost, like that of types of cost, cannot be solved merely by means of a universal grid.

First, as far as PI is concerned, what monetary units should be used to express costs which have been calculated separately for each phase? Cost per pupil, frequently used in evaluating traditional instruction, cannot be used here precisely because PI makes it possible to serve widely differing numbers of pupils for the same production costs; the cost per pupil, therefore, although very significant as far as reproduction is concerned, is no longer relevant in connexion with production. Instead, therefore, it was decided to use cost per hour, which has the advantage that one can use it for each phase of PI;[1] this means, however, that an hour of mathematics is equated with an hour of languages or an hour of marketing. While this may shock the pedagogue, it is quite reasonable in economic terms and almost unavoidable in any attempt at empirical evaluation; we consider that it can more easily be justified than the always unsatisfactory attempts to apply differential weighting.

The unit originally selected, in fact, because it was felt to be more 'meaningful', was the student-hour; it was finally abandoned for the production phase because it was soon found to inhibit comparisons and, *a fortiori*, scientific extrapolations—which are precisely what the planner needs. Using this unit, in point of fact, ten programme hours for one student are equal to one programme hour for ten students, which is both pedagogically and economically unacceptable. This problem is rendered even more acute by the existence of highly different media with considerable variations, which the student-hour cannot allow for, in their utilization rates.[2]

The difficulty of selecting a unit is merely the corollary of the uncertainty that exists concerning the product of PI, which tends to be different from one phase to another, consisting of the preparation of teaching material in the production phase followed by the reproduction of that material and finally by the production of teaching hours.

United States', in: Scanlon and Weinberger (eds.), *Compiled Bibliography on Improving Productivity of School Systems Through Educational Technology*, Philadelphia, Pa, Research for Better Schools, Inc., 1974. There can be no question of attempting to quantify this item in this survey, but it should be kept in mind for the following section on units of cost and also in connexion with the interpretation of results and any comparison with the performance of other educational methods.

[1] All monetary costs are expressed in United States dollars at the 1974 rate.

[2] In the case of PI based on printed media, for example, there is no means of knowing how many times the books are used. (The same is true concerning exercise books.)

The same difficulty arises as soon as an attempt is made to separate fixed from variable costs: in the production phase, the length of the programme is the sole factor which affects costs, whereas it is only one of the factors—together with the number of students and the frequency of programmes—affecting reproduction costs.

In view of the criterion of student numbers, it was therefore decided to consider production costs as being fixed and reproduction costs as being variable. In reality, there is no such thing as a truly fixed cost in relation to the two variability criteria.

Second, is it possible to avoid these various difficulties by selecting non-monetary units? The alternative we have in mind is that of costs expressed in terms of time, on which great hopes are often pinned. The idea is that expressing costs in this way has the merit of being simple (which would reduce the number of cost-measurement errors) and also lends itself more readily to comparisons (between types of media, types of instruction and even between different countries).

It would accordingly be sufficient, by means of an operation similar to task analysis, to record the production time required for the preparation and utilization of programmes, and to use this general equivalent for the purpose of making direct comparisons between experiments.

Enthusiasm for this method of expressing costs, however, should be tempered by the fact that it involves several problems:

1. It does not eliminate the difficulty of evaluating the unit content: is one hour of a psychologist's time worth the same as one hour of a highway-code monitor's time? An affirmative reply to this question can lead to anomalous results and is, in any case, no improvement on the assumption made for the purpose of calculating in monetary terms; a negative reply, on the other hand, calls for the application of a weighting procedure which involves comparing salaries, i.e. those very monetary units it was hoped to avoid.[1]
2. Expressing costs in terms of hours cannot change the fact that there are several successive phases, each with different products: input hours for the conception, production and—to a minor extent—reproduction phases and output hours, defined as constituting the programme's duration, for the programme-operation phase.

The hourly cost calculations are still concentrated mainly on the production phase, since that is the phase for which there is the most information available to make the figures meaningful, and it is the only phase in which the mode of utilization of resources really corresponds to the concept of hourly inputs.

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[1] In these circumstances it was decided to adopt the first 'solution' for the purpose of the calculations; in order to avoid this drawback, the figures are left as aggregates (covering all professional categories).

2. Results

Following the general methodological principles stated above, we shall set out separately the evaluation for each successive phase of PI development.

2.1 *Production*

2.1.1 *Monetary costs*

Bases for calculation. The total monetary costs of the production phase (using the term broadly to include the pre-production phase) are first of all calculated without making any distinction between the various sub-phases: pre-production, preparatory phase, realization and validation.[1]

There are three preliminary points to be made:

First, many of the educators questioned make no distinction between pre-production (or feasibility) activities and the preparatory phase; because of this they do not show the costs separately—which was another reason for incorporating the feasibility study in the production phase.

Second, the questionnaires show the cost of training the staff responsible for the programme in the pre-production phase, with the 'option' of including them in the production phase, and this also justifies combining these two phases.

Third, a final justification is afforded by the fact that it turns out to be usually the same staff who are responsible for carrying out or supervising the various production sub-phases, which means that separate calculations for each of the sub-phases would be somewhat arbitrary.[2]

Before setting out and commenting on the results obtained, mention must be made of two other methodological problems relating to the method of calculating capital expenditure and, in particular, to the method of dealing with amortization.[3]

1. In line with the approach adopted, no attempt has been made to calculate interest in evaluating this amortization; such interest would, in effect, constitute an opportunity cost in respect of the resources invested and, while the existence of potential alternative uses is not

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[1] This is the procedure employed by R. Layard and M. Oatey, who suggest making an over-all calculation of master costs. See: R. Layard and M. Oatey, 'The Cost-effectiveness of the New Media in Higher Education', *British Journal of Educational Technology* (London), Vol. 4, No. 3, 1973.

[2] In calculating the figures, no account has been taken of what is in fact more a theoretical than a statistical distorting factor: that caused, in the case of programmes (or parts of the PI system) which are bought or sold, by the inclusion of profit margins in the purchase price (of inputs) or the sale price (of products). Any attempt to evaluate this distortion would in the present context be disproportionate to the degree of precision of the data.

[3] This point is equally valid for subsequent phases of the programme.

denied, the cost of forestalling them cannot theoretically be calculated except as part of a cost-effectiveness study. It is assumed in this respect that there are no alternative uses for the money invested. Obviously this applies particularly in the case of public investment. In any event, since the institutional settings in which the experiments were carried out were extremely diverse, the heterogeneity of the markets represented in the sample makes it impossible to determine such alternative uses and hence to determine the amount of interest that would have to be imputed to take account of them. Furthermore, it has to be assumed, from the information available, that the equipment has been purchased outright rather than by borrowing—an assumption which is reasonably realistic in that the equipment, except in the rare cases of computer-assisted PI, is made up mainly of inexpensive items.[1] On the basis of this assumption, therefore, there is no need to calculate the interest charges which would have arisen from a credit purchase. Variations in the values of national currencies, on the other hand, have been taken into account, and for this purpose all expenditure has been expressed in dollars at the 1974 rate of exchange, by applying the appropriate deflaters.

2. A second methodological point in regard to the equipment remained to be settled, i.e. the problem how also to take into account its utilization rate. In so far as certain machines are not used full-time for PI (and this holds good for all phases of the programme), the reason is often that they are allocated to other teaching activities (whether of a technological or of a traditional kind). Rather than make complex calculations for imputing the amounts concerned (which would have been out of all proportion to the quality of data available), it was decided to produce two types of alternative results: the first have been calculated *pro rata* to the total length of time the machines were in use in the establishment; the second, which are more normative, have been estimated on the assumption that the equipment was used entirely for PI activities, with a flat utilization rate of 1,880 hours per year.

Average total costs. Going on from the costs of each experiment[2] to average costs for the different types of PI gave rise to a new methodological difficulty concerning the way to calculate these averages. After establishing weighted averages taking the final duration of the programme into account for each experiment, it became apparent that this process could produce misleading costs per hour and that it would be better merely to calculate the averages on the assumption that the

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[1] This shows that PI has not yet reached the 'industrial' stage.

[2] Arrived at by interpolations based, in the absence of certain data, on the characteristics of each type of experiment.

Table 43. Hourly production costs ($\frac{\sigma}{m}$ = coefficient of variation), not adjusted for duration, in 1974 United States dollars

Group	Programme duration	Staff cost		Cost of material[1]		Cost of equipment[1]	
		Amount	$\frac{\sigma}{m}$	Amount	$\frac{\sigma}{m}$	Amount	$\frac{\sigma}{m}$
1.1	8 h 20 min	2,432	0.6	83	0.8	3.5 (1.8)	0.6 (0.6)
1.2[2]	2 h 55 min	15,566	1.0	1,251	1.4	104 (53)	1.0 (0.9)
1.2[3]	1 h 30 min	12,024	1.4	216	1.0	82.1 (41.1)	1.3 (1.3)
1	5 h 12 min	9,937	1.3	750	1.9	61 (31)	1.5 (1.5)
2.1	20 h 30 min	1,501	1.4	299	1.5	9 (2)	1.2 (0.9)
2.2	31 h 07 min	2,133	0.9	465	0.9	2.7 (1.9)	0.5 (0.7)
2	24 h 28 min	1,731	1.2	360	1.2	6.7 (2)	1.4 (0.8)
3.1	5 h 30 min	429	1.9	78	1.7	2.1 (1)	1.9 (1.9)
3.2	1 h 00 min	732	0.5	174	0.6	19 (9.6)	0.5 (0.5)
3	4 h 10 min	516	2.1	106	1.7	7 (3.5)	1.7 (1.7)
4.1	15 h 00 min	3,396	0.8	42	0.8	13 (6.5)	0.8 (0.8)
4.2	3 h 00 min	1,155	0	200	0	6.3 (5)	0
4	11 h 00 min	2,646	0.5	95	0.6	10.9 (6)	0.8 (0.8)

1. The first figure represents actual utilization, the second (in parentheses) a flat annual utilization rate (1,880 hours).
2. Including computer-based experiment.
3. Excluding computer-based experiment.

Table 44. Average hourly production costs in 1974 United States dollars

	Staff cost	Cost of material	Cost of equipment[1]
Cost per hour	4,152	658	23.7 (11)
Coefficient of variation ($\frac{\sigma}{m}$)	2	2.7	2.3 (2.3)

1. Equipment costs: the first figure represents actual utilization, the second (in parentheses) a flat annual utilization rate (1,880 hours).

experiments were equivalent and thus each carried the same weight (Table 43).

The over-all results, i.e. totalled for the whole sample, as they appear in Table 44, must be used and interpreted with caution, as is clear from their coefficients of variation; they can thus scarcely claim to be more than quantitative approximations but are none the less valuable for making comparisons between different forms of technology and between different types of PI and different media. In order to make such comparisons, it is in fact necessary to gain a better understanding of the true significance of these figures.

This is why, before proceeding further with the calculations, it is necessary to look for a moment at these total figures.

The first conclusion to be drawn from these results is that the industrial character of PI is not evident in the production phase, which is, on the contrary, to a large extent 'labour-intensive': conceiving and

TABLE 45. Cost of each item as a percentage of average hourly costs (averages not adjusted) in 1974 United States dollars

Type of PI	Total average cost per hour	Staff costs (%)	Material costs (%)	Equipment costs (%)[1]
1.1	2,518	96	3	1
1.2	16,921	92	7	1
1	10,748	92	7	1
2.1	1,809	83	16	1
2.2	2,600	82	17	1
2	2,097	82	17	1
3.1	509	84	15	1
3.2	925	79	19	2
3	629	82	17	1
4.1	3,448	98	1	1
4.2	1,361	85	14	1
4	2,750	96	3	1

1. Calculated on the basis of actual utilization.

writing the programmes has to be done by staff who are both academically and pedagogically specialized, not to mention the purely technical skills required for using complex media.[1] Thus, on average, 85 per cent of production costs is accounted for by salaries, compared with 14 per cent for material costs and only just over 1 per cent for capital expenditure. This cost distribution is not affected by the method of calculating averages nor, by and large, does it vary much for the different types of PI (see Table 45).

If we regroup these types in the manner suggested above, we can then examine more closely the scatter of the results for the different groups, as can be seen in Table 46.

While the marked general scatter of costs clearly confirms our initial assumption, i.e. that PI has a multiplicity of forms and types of content (as is also shown by the differences in programme duration), it is also possible to discern some interesting trends. First, systematic observation of the extremes makes it possible to distinguish two types of experiment:

1. At one extreme, PI, which is provided for students in public education establishments, using other than printed media, has an extremely high production cost in comparison with the other

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[1] The ratio of material costs to staff costs is certainly consistently greater for PI using non-printed media than for PI using booklets, but no parallel trend can be discerned where equipment costs are concerned. This demonstrates very clearly the complementary relationship between labour and capital at the production stage: forms of technology using complex hardware (teaching machines, computers) are demanding in regard to specialized labour, at least during the programme-conception stage.

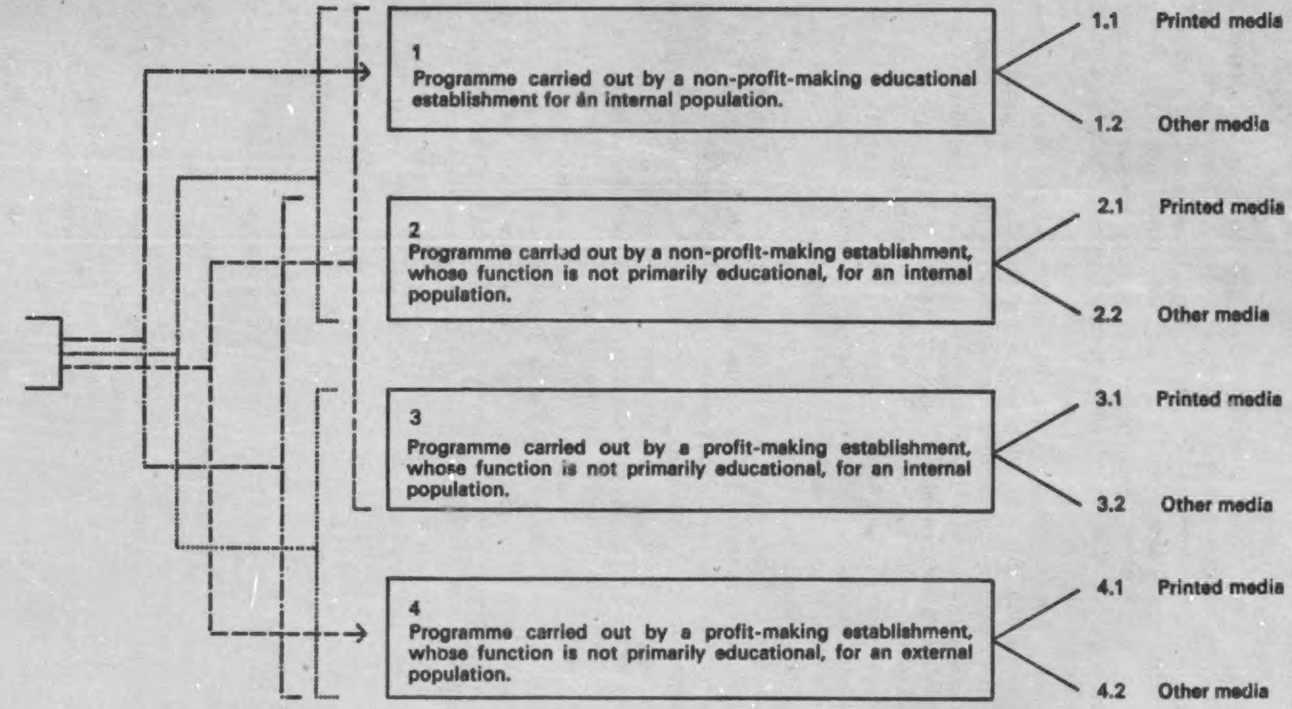
1
Programme carried out by a non-profit-making educational establishment for an internal population.
1.1 Printed media
1.2 Other media
2
Programme carried out by a non-profit-making establishment, whose function is not primarily educational, for an internal population.
2.1 Printed media
2.2 Other media
3
Programme carried out by a profit-making establishment, whose function is not primarily educational, for an internal population.
3.1 Printed media
3.2 Other media
4
Programme carried out by a profit-making establishment, whose function is not primarily educational, for an external population.
4.1 Printed media
4.2 Other media

Fig. 4. Types of programmed-instruction experiment.

TABLE 46. Average hourly production costs by groups of PI types (averages not adjusted) in 1974 United States dollars

Criterion		Programme duration		Staff costs	Material costs	Equipment costs[1]	
Type of establishment	Profit-making (3, 4)	6 h	Hourly cost	1,155	102	8.1	(4.3)
			Coefficient of variation	1.4	0.8	1.2	(1.1)
	Non-profit-making (1, 2)	17 h	Hourly cost	4,922	512	27.8	(13.3)
			Coefficient of variation	1.9	2	2.2	(2.4)
Function of establishment	Mainly educational (1)	5 h 12 min	Hourly cost	9,937	750	61	(31)
			Coefficient of variation	1.3	1.9	1.5	(1.5)
	Mainly other than educational (2, 3, 4)	15 h 10 min	Hourly cost	1,456	237	7.3	(3)
			Coefficient of variation	1.3	1.5	1.3	(1.2)
Student population	Internal (2, 3)[2]	15 h 50 min	Hourly cost	1,258	261	6.8	(2.6)
			Coefficient of variation	1.3	1.5	1.3	(1.3)
	External (4)	11 h	Hourly cost	2,645	95	10.9	(6)
			Coefficient of variation	0.9	0.8	0.9	(0.7)
Medium of instruction	Printed media (1, 2, 3, 4)	12 h 46 min	Hourly cost	1,573	166	6.5	(2.2)
			Coefficient of variation	1.2	1.9	1.3	(1.2)
	Other media (1.2, 2.2, 3.2, 4.2)	12 h 50 min	Hourly cost	6,674	674	43	(22.2)
			Coefficient of variation	1.7	1.8	1.8	(1.8)

1. The first figure represents actual utilization, the second (in parentheses) a flat annual utilization rate (1,880 hours).
2. In the strict sense, i.e. including school pupils and university students.

experiments—about eight times greater than the average for the remaining experiments. In actual fact, this group includes a PI experiment carried out exclusively by computer means; this experiment is the only one in the sample to which this applies and greatly increases the average figure of costs for this type of PI, even though it cannot be considered statistically abnormal in relation to the other non-computerized or semi-computerized multi-media experiments.

2. At the other extreme, the cost of programme production for in-service training in private firms is roughly eight times less than in the other experiments (whatever medium of instruction is used).

This first conclusion shows that one of the factors which determine the cost of PI is the way in which it is used—as a small-scale experimental tool or as a regular training instrument. In the first case, it must be considered as much a form of research as of instruction, even if the activity takes place in a nominally educational establishment, and the high costs must be attributed to various factors which are inherent in experimentation and innovation rather than to poor management of resources. In the second case, PI is totally integrated into a well co-ordinated and well tried system of training activities and is used with greater frequency and for a larger number of students.

It may indeed be assumed that, where PI forms part of in-service training in firms, it has a distinctly recurrent character; its cost, moreover, forms part[1] of the wages bill and, as such, is kept as low as possible by the firms concerned. The same considerations cannot apply to recurrent in-service training provided in non-profit-making (administrative) establishments, where programme-production costs are in fact found to be slightly higher. The production cost of programmes used by firms for outside students are higher again, and this is due to the fact that these firms, as sellers of PI, probably tend to overestimate their costs.[2]

As production costs consist mainly of staff costs, the low level of these costs, when they relate to in-service training in firms, suggests that this training—at least as far as the programmed part is concerned—is of a specific nature.[3] In other words, the programmes in question cover technical skills peculiar to the firm or industry and can be conceived at minimum cost by internal staff with the (relatively minor) assistance

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[1] Either directly or indirectly, depending on national regulations.

[2] This overestimation is not due to any bias in the replies to the questionnaire but reflects the differing degrees of internalization to which attention was drawn at the beginning of this report; it also illustrates the fact that a commercial producer is less likely to make the mistake of considering inputs to be free. Any over-all estimation of costs is therefore not in absolute terms but obviously in relation to assessments made in a non-commercial context.

[3] See: G. S. Becker, *Human Capital: a Theoretical and Empirical Analysis, with Special Reference to Education*, New York, N.Y., Columbia University Press, 1964.

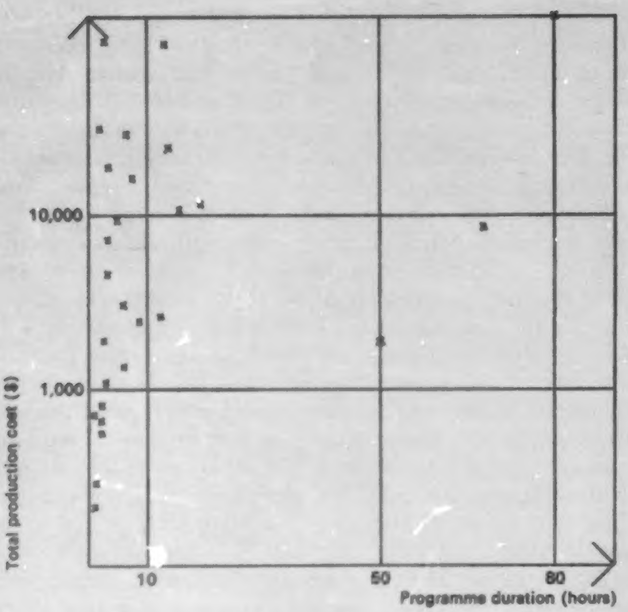

FIG. 5. Total production cost in relation to programme duration.

of PI technicians from outside the establishment; and this certainly seems to be borne out by the titles of the programmes in question.

Variation factors. After this rapid survey of the production costs of the different types of PI, it is now necessary to specify these costs more precisely and to identify and bring out into the open the variable factors which have until now remained implicit but whose influence can be guessed at.

Final duration of programmes. It can be seen from correlation tests and from the graph in Figure 5 that there is a link between the duration of a programme (output in hours) and the hourly cost of its production; this link corresponds broadly to what might be expected in accordance with the principle of economies of scale, i.e. a decrease in hourly costs as programme duration increases, but this decrease is both irregular and ultimately not sufficiently significant for it really to rank as an application of this principle.

There is no reason to feel downcast about this; on the contrary, it provides a timely warning against unverified application of the concept of economies of scale and against the confusion which all too frequently occurs between this concept and another law of classic economics—that of diminishing returns. We would remind the reader who is not an economist that an economy of scale is an increase in output which is proportionally greater than that of all the factors making up the combination. The law of diminishing returns is very different: this states that 'if increasing amounts *of a variable factor are applied to a fixed quantity of the other factors*, the amount added to the total product by each additional unit of the variable factor will eventually decrease.'[1]

Adjusting production costs, however, in relation to the hourly duration of the final programme does not, strictly speaking, give a true reflection of either phenomenon, since production, although a decisive factor, on the one hand does not represent the entire combination of elements and, on the other, does not in itself constitute a production factor in respect of the final product: a single phase of the production process cannot be identified either with the process or with its inputs.

In less technical terms, the following two provisional conclusions may be drawn: (a) current PI experiments indicate that, as far as production is concerned, the gains accruing from more intensive use (in terms of programme duration) of PI, although possible, are still fairly limited—the performance achieved by teaching and technological skills in conceiving the programmes does not increase perceptibly unless the duration of the final programme exceeds a threshold value which may be set at about six to eight hours;[1] (b) from a methodological point of view, there arises, in addition to the aforementioned considerations, a danger of confusion when comparing the final output and the cost of intermediate production phases if units are used which take on a different meaning according to the level at which they are applied.[2]

The wide scatter of the results—wider than can be explained by the variables explicitly taken into account—makes it desirable to give a fuller description of the PI experiments which make up the sample in order to try to discover how far this scatter of production costs is related to the differences (or similarities) between the experiments and classic PI.

Since no great assistance, in this case, can be derived from the final duration of the programme, we shall turn to the circumstances in which the programmes were introduced and, first of all, to the stages in their construction.

Existence of a pre-production phase. Classification of the experiments in accordance with the presence or absence of this phase and the corresponding calculation of production costs after deduction of pre-production

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[1] R. G. Lipsey, *An Introduction to Positive Economics*, 3rd ed., London, Weidenfeld & Nicolson Ltd., 1973.

Table 47. Hourly production costs (excluding pre-production costs) in 1974 United States dollars, according to whether or not a pre-production phase has taken place[1]

	Type of PI			
	1.1	2.1	2.2	3.1
Experiments which include a pre-production stage	3,545	2,396	2,615	7,493
Experiments which do not include a pre-production stage	721	720	1,640	925

1. Averages not adjusted. The costs comprise staff costs, material costs and equipment costs (the last being calculated on the basis of actual utilization). This table contains only those types of PI which can be divided sufficiently evenly into experiments containing a pre-production phase and those which do not contain such a phase.

costs (Table 47) reveals a much sharper contrast, in fact, than that shown by the preceding factors: in cases where a complete feasibility study was carried out,[3] the strict production costs, i.e. excluding the cost of that study, are on average five times greater than when no such study has been carried out. What is more, the former category includes a large number of educational establishments (type 1).

In so far as the execution of preliminary, independent feasibility studies can be considered an indication (if not a guarantee) of the PI's authenticity, these results show that the PI experiments which are least expensive to produce are those which appear to depart furthest from the basic PI formula; experiments realized by establishments which have carried out pre-production work are also those which included the largest component of labour specialized in the production of PI sequences.

Although pre-production costs per programme hour show a particularly wide scatter because of the difficulty of identifying such costs, they nevertheless appear to occupy a fairly large place in total production costs (accounting for about 18 per cent of these costs).

The replies provided in the investigation suggest that the existence of preliminary studies tends to be associated with experiments using

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1. In the cluster of points representing hourly production costs as a function of programme duration, differences in types of PI and even in types of medium are seen to exert a lesser influence.
2. R. Layard and M. Oatey, having described the presentation-hour as 'the natural unit of output', arrive at a very similar conclusion when they turn to the question of comparisons between media.
3. That is, in those experiments where the questionnaire shows costs separately for this sub-phase.

TABLE 48. Hourly pre-production costs (averages not adjusted) in 1974 United States dollars

Type of PI	Printed media	Other media	Type of PI	Printed media	Other media
1	15	2,018	3	4,955	—
2	797	454	4	471	—
			TOTAL	1,474	1,496

printed media, but estimates of the cost of these studies (Table 48) appear to be independent of the type of media—or, more precisely, the available data are insufficient to reveal the form of any correlation which may exist.

It is reasonable to assume, however, that the cost of pre-production tends to depend on variables relating either to the size of the student population to be catered for or to the type of medium, considered as a factor of the cost of the other phases of production rather than in relation to the pre-production phase itself.

Validation procedure. A second possible indicator by virtue of which an experiment can be identified as fulfilling the requirements of a programmed graded-learning operation is the existence, at the end of the operation, of a validation procedure which consists in testing 'the value of the programme in the context of normal use, which may well be different from the experimental context'.[1]

The indirect impact of this procedure on production costs can be measured by calculating these costs for sub-groups of experiments, depending on whether or not they incorporate such validation: establishments which have carried out a comparative evaluation, $4,407; establishments which have not carried out a comparative evaluation, $3,796.

The slightly higher production costs for complete programmes[2] is another instance of the phenomenon referred to above: the establishments with the lowest costs are those which consider themselves the least bound by PI's normal limitations and, in particular, by the need to carry out time-consuming pre-production and validation phases.

Evaluation procedures at the end of production, where they exist, are so closely integrated in production that it is exceedingly difficult to assign a cost to them, as shown by the confused data on this point in the questionnaires. Apart from validation operations in the strict sense (sample checks carried out on a pilot group of students required for the tests) which are in any case very rare, validation, in the way in which it appears to be carried out in practice, does not require the use of staff other than that employed on the over-all production; all in all, validation seems to amount to a routine activity and can therefore be expected not to entail very large extra costs.

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[1] M. de Montmolin, *L'Enseignement Programmé*, Paris, Presses Universitaires de France, 1971. (Que Sais-je?, No 1171.)

[2] The majority of validation procedures are carried out for programmes using printed media. Comparative validation is taken to mean a comparison between the results of traditional instruction and those of PI. According to the investigation, it is carried out only fairly infrequently. Evaluation of the effectiveness of PI's actual results is more frequent and shows generally very high success rates which approximate to those expected (an 85–90 per cent success rate).

In reality, as far as can be gauged from the figures, the costs of the validation carried out at the end of the production phase fall into two groups on either side of an average of 15 per cent of the total production cost. In the first group, the validation costs are well below 10 per cent of production costs; this group consists essentially of educational establishments and PI experiments using printed media. The use of low-paid or unpaid labour (students for the pilot groups) probably explains the presence of these establishments in this group, while printed media are obviously inexpensive to use. The second group, consisting of the other types of establishment using more complex media, show validation costs of the order of 40 per cent of production costs.

Hence, when it exists, which is rarely, especially in type 4 experiments, validation is a fairly expensive operation, which explains why it tends to be practised in situations where its cost is not visible (public establishments).

Use of PI as a complete system or sub-system. Another question capable of providing information on PI's specific importance as a teaching method was that relating to the use of PI as a complete system or as a sub-system (in relation to a more comprehensive set of teaching methods). In point of fact, the confusion caused by this question rules out any precise interpretation of the answers, except perhaps that experiments in which PI is looked upon as a system in itself indeed have higher production costs ($6,585 per hour) than those in which it is part of a larger system. This is a further indication of the fact that genuine PI which constitutes a self-sufficient process entails greater expenditure.

Associated indirectly with this, the amount of 'seniority' enjoyed by PI in each establishment was checked against its production costs. The dates when PI began to be a fully operational experiment are too close together to have had an effect on costs or possibly to bring about a reduction in costs after a longer period of operation.[1]

Research work in the PI field. In similar vein, a test was carried out on the possible influence of this on the total cost of production. Despite the fair number of questions on this subject in the questionnaire, it is

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1. There is, incidentally, no significant correlation to be seen between the production costs of the programme analysed in each establishment and the number of PI experiments previously carried out in that establishment.

very difficult to draw any definite conclusions from them. It seems likely in fact that in some cases those who provided the answers confused pre-production operations, or even programme-conception and validation operations, with the broader research activity the questionnaire was attempting to cover. In other cases they interpreted 'research' as referring to the trials and market research carried out in connexion with the promotion of a new programme; this seems to have happened in connexion with the type 2 experiments in particular (in-service training in non-profit-making establishments). Because of this, the tests do not reveal any significant differences in costs which could be ascribed to the existence of really systematic research.

Actual content of the subject being programmed. This is the one remaining *a priori* decisive variable which has not yet been explicitly taken into consideration even though, in reality, as indeed suggested by the foregoing analysis, it has considerable influence on the scope of the programme-conception work and is already partly incorporated in the variables examined thus far.

There are several possible ways of defining programme content. The experiments could be classified by the type of subject taught as indicated by the programme title. However, the qualitative nature of the subjects, which gives no indication of the degree of difficulty of the programme, makes this approach unreliable; furthermore, apart from those provided in educational establishments, the programmes are very largely concerned with vocational training and it is therefore very difficult to classify them from their titles (or even from other data in the questionnaire). Nor is it very effective to classify the experiments in accordance with the general educational level of the students concerned since, as these are mainly working adults, a problem arises concerning the link between the content and level of instruction, on the one hand, and the nature and level of the students' employment, on the other.

It was finally decided, therefore, to base the test on the conditions laid down for participation in the PI experiment: on the assumption that insistence on a certain level of knowledge indicates a programme which has involved the expenditure of more effort in the way of conception and validation than has a simple programme which is sufficiently general to be suitable for students with diverse scholastic backgrounds, an effort was made to check the evaluation of this difference in monetary terms.

Experiments requiring only the equivalent of a secondary-level education or less were therefore placed into one group, the other group consisting of PI experiments access to which requires either a general higher education or the successful completion of an examination or test relating to a specific level of training.

The picture obtained by applying the admission criterion to the various types of PI is in fact broadly comparable to that obtained by means of the first two criteria examined: establishments which make

TABLE 49. Hourly production costs (averages not adjusted) according to admission level, in 1974 United States dollars

Type of PI	Restricted admission	Unrestricted admission	Type of PI	Restricted admission	Unrestricted admission
1.1	4,703	1,425	2.2	6,917	1,162
1.2	33,310	532	3.1	22,016	409
2.1	7,584	841	4.1	6,279	676
			TOTAL	14,264	798

pre-production studies are often those which recognize the need for validation, and it is frequently the same establishments which lay down conditions for admission to the education they provide. Comparison of hourly production costs for the different types, according to whether or not the programme is subject to the educational level of the clientele, thus produces results which are fairly similar to those obtained by comparison in accordance with the other two criteria.

This new criterion, however, produces a much greater cost differential than the preceding criteria: Table 49 shows one group of experiments with unrestricted admission, costing $800 per programme-hour to produce, contrasted with another group of experiments for admission to which a high level of education is required, costing seventeen times as much to produce.

This extremely marked difference in costs between the two groups suggests that the variable used has a powerful polarizing effect, bringing together a cluster of traits typifying experiments with a high educational level and programmed according to true PI principles, on the one hand, and, on the other, routine educational experiments which are enhanced by teaching techniques that are only fairly remotely connected with theoretical PI.

Hence, as far as production is concerned, it is clear that the complexity of the subject taught is reflected in the complexity of programming.

The configuration of PI production costs in relation to the complexity of the content to which it is applied thus reflects the fact that programming a subject calls for staff who are familar both with the teaching material itself and with the technique of programming. More precisely, we seem justified in concluding that the degree of pedagogical difficulty exerts a multiplier effect on the programming itself, which is reflected in the costs.

Audio-visual centre

Cost-effectiveness in resource-based learning[1]

Synopsis of the organization of audio-visual centres in the Federal Republic of Germany

Schools and institutions for youth welfare and adult education in the Federal Republic of Germany exist at four levels:

The audio-visual centre at federal level
The Institut für Film und Bild in Wissenschaft und Unterricht in Munich-Grundwald is responsible for producing audio-visual media and observing the products of similar institutions in other countries, where necessary adapting them to their own programme. It inspects the hardware market and exchanges examination results with neighbouring countries. The production costs of the media are borne by the states of the Federal Republic. The end-products are handed on to the audio-visual centres at other levels for the cost of reproduction.

The audio-visual centres at state level
These concern themselves mainly with systematic testing of media and the further education of assistants in subordinate positions. They also have at their disposal archives which are made available to regional audio-visual centres.

The audio-visual centres on the urban or rural district level
These centres are responsible for directly furthering the use of audio-visual material in schools, youth welfare and adult education. The different categories are as follows:

Pedagogic tasks. Training and further education of teachers and instructors in institutions for adult education and of volunteer youth-welfare workers in respect of the pedagogic-didactic application of audio-visual material. This is accomplished with seminar courses, single seminars and personal consultations.

Technical tasks. Repair of equipment and introduction to use of equipment. Consultation with educational institutions on procurement of equipment.

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[1] Extracts from a communication delivered at the Congress of the International Council for Educational Media, Glasgow, United Kingdom, 1–5 October 1975, by Walter Wiegel, Institut für Film und Bild in Wissenschaft und Unterricht, Göttingen, Federal Republic of Germany.

Archives. Establishment of film and tape archives with recordings of regional importance.

Loans. Loans to educational institutions of films, slides, tapes, cassettes, records, recorded videotapes and packages of transparencies for overhead projectors.

The local audio-visual centres
These result from the collection of educational aids in individual schools. Educational aids and school libraries are being brought together and built up into school media centres. The establishment of carrels for small group or individual work deserves special emphasis; these enable school media centres be built into to self-learning centres for adult education as well.

Case study: the District Media Centre, Kreisbildstelle, Göttingen

In order to enable a comparison to be made between the District Media Centre, Göttingen, and similar institutions in other regions, some background information is required. Statistics for 1974 for the District of Göttingen were as follows: inhabitants, 253,000; schools, 152; Classes, 1,620; full-time pupils, approx. 41,000; employees in educational system, approx. 2,500; salary for employees in the educational system, approx. $40 million;[1] building and maintenance of schools, approx. $16 million.[1]

The district of Göttingen covers an area of approximately 1,120 square kilometres and of the population of 253,000, almost half live in the town of Göttingen itself. The town houses the University of Lower Saxony and a department of the Teacher Training College of Lower Saxony, with a combined enrolment of approximately 22,000 students, and also the main administrative body of the Max Planck Society for the Promotion of Sciences and some of its research institutes. Factories for the manufacture of precision instruments, optical and light electrotechnical equipment have also been established in the town. The remainder of the district is mainly agricultural.

The district provides for a total of about 40,000 full-time pupils (the teaching load of part-time pupils has been converted into full-time hours). They are taught in 1,380 classes, distributed amongst 110 schools of varying size (one to sixty classes). For the past two decades, the district has been attempting to dissolve the smaller schools, placing the pupils together in central schools. The cost of transporting pupils to the central schools would be raised by public funds.

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[1] Throughout this chapter U.S. $1 = DM.2.50.

Approximately 2,500 people in the district of Göttingen are employed in the educational system, including school administration and supervision, and for these an estimated DM.100 million must be found per year, inclusive of training costs, social benefits and old-age pensions. Throughout the whole district, the additional yearly average over the past five years for building and maintenance of schools amounts to DM.40 million which means that approximately DM.140 million is spent on education. Thus, taking an average of 25 teaching hours per week and 29 pupils per class: 1 teaching hour per class costs DM.100 ($40) and 1 teaching hour per pupil costs DM.3.45 ($1.75). A rough estimate is assessed at ±4 per cent.

The District Media Centre has grown during the last twenty years from a one-man concern to a centre with twelve employees and six scientific assistants, paid by the State, who are freed from part of their teaching duties. The employees comprise: 1 chief administrator; 1 official expert, deputy to the chief administrator; 1 secretary; 5 administrative clerks, who take care of the loan transactions; 1 photographer; 1 television and radio technician; 2 drivers and the Director of the establishment (Dr Walter Wiegel). (See Fig. 6.)

It was estimated that DM.850,000 from the district's budget were required for the maintenance of the audio-visual media centre for the year 1975, with staff costs representing a total of DM.360,000. Thus, the district spends a total of DM.3.45 ($1.75) per inhabitant for the regional media centre. For purposes of comparison, it may be mentioned that the town of Göttingen expends DM.9.50 ($3.75) per inhabitant for the town library.

The media equipment available for loan at the District Media Centre is valued at approximately DM.3 million. With the help of two delivery vans, the educational institutions in the districts receive deliveries once a week. About 30 per cent of all material requested is picked up directly from the loan archives by teaching staff and school assistants.

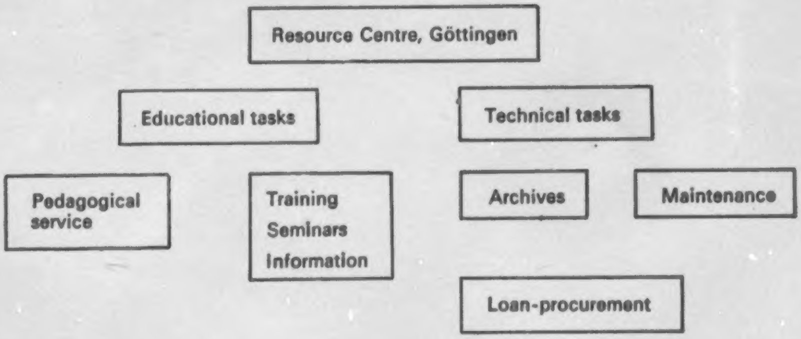

FIG. 6.

To avoid long journeys by people collecting their own material—the district stretches 50 kilometres east and west—branches of the audio-visual centre have been set up in the two smaller towns on the outskirts of the district.

All teachers so desiring receive a comprehensive catalogue, with titles of films, slide series, tapes, cassettes, records, transparencies, video-cassettes and specialized books which for educational purposes are at the disposal of the borrower free of charge in the collections of the district audio-visual centre, of the state audio-visual centre, of the Federal Centre for Political Education, and elsewhere.

Furthermore, the media centre also rents material from commercial loan centres for the borrowers, so long as payment of rental charges presents no problems.

Subject catalogues are assembled which also contain such titles as are not available in the media centre.

For the year 1975, approximately 50,000 loans will be granted, 90 per cent of them within a maximum delivery time of ten days.

At present, the town library makes approximately 350,000 loans yearly. About 3 million people are reached by the 50,000 loans of the District Media Centre, each item being demonstrated twice on the average. Thus, for example, viewing a filmed stage play leaves a deeper impression and is therefore more effective than reading a printed stage play. The same difference exists between listening to and reading a radio play. While the centre's archives contain material whose educational effectiveness is less intensive, the town library has many books which can at best be called superior light reading (see Fig. 7).

The yearly turnover of the media centre, i.e. the value of the material which is delivered during a year from the archives to educational institutions reached an approximate total of DM.17 million in 1975. The yearly turnover of the town library amounts to approximately DM.1 million.

Other Resource Centre activities

The courses designed to provide an introduction to the use of equipment are a permanent feature of the regional media centre. The introductory course is provided every Thursday afternoon except during the holidays. As the number of teachers registering for a course cannot always be dealt with by one afternoon course per week within a reasonable period of time, additional introductory days have to be arranged, giving a figure of sixty courses per year.

Some aspects of the course can be converted to programmed self-learning material. For this purpose, eight self-teaching items of equipment were purchased. The equipment installed by the firm Intertip, Zürich, was supplemented by an automatic slide-projector synchronized with a sound cassette, from the firm of Hoppe & Schneider, Lehrsysteme, Heidelberg. Equipment has been introduced systematically.

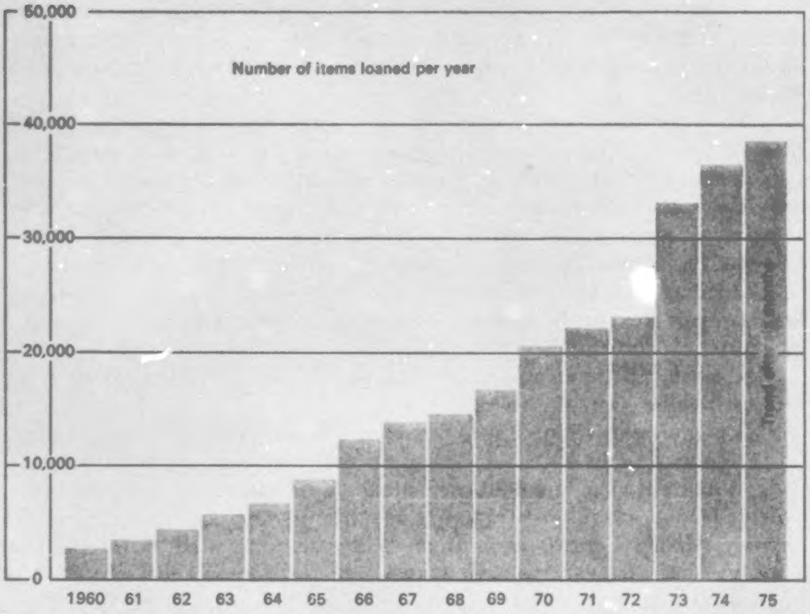

FIG. 7.

The course participants listen to the information on the tape. Questions are answered by means of signalling keys using the multiple choice method. The answers are offered optically for selection. After every question, the apparatus stops and only proceeds further when the correct answer key is pressed. Incorrect answers are counted on an electronic meter. An extension of this apparatus is planned, so that branch programmes and repetitions are made possible, without synchronization of sound and picture being lost.

The use of self-teaching devices in the introduction of teachers to the use of audio-visual equipment is also designed to acquaint the teacher with the operation of programmed teaching equipment.

An important aspect of the work of the District Media Centre is the promotion of school radio and television. Work in this field could be made substantially more effective, if it were not restricted in the Federal Republic of Germany by complicated copyright regulations.

Cost-effectiveness

With 20,000 loans per 100,000 inhabitants, the centre—at any rate in Lower Saxony—is the leading school media centre. Whether the schools in the district of Göttingen, with their 50,000 requests, support their teaching through media to the desired extent or only to the extent made possible by the titles offered is another question. At the moment, assertions to this effect can be made only on the basis of rough estimates. We are here concerned solely with loans of visual aids.

Since some schools already have their own collections, the loan figures for the media centre in the slide-series section are not a reliable basis for statements concerning the extent to which these media are used in schools.

What is striking is that the use of visual media varies greatly from school to school. Of course, the comparison is between specific and not absolute figures, i.e. the number of loans per class. If these differences are followed up, it can be established that they are above all connected with the percentage of schoolrooms which can be used for colour film projection (screens, blackout facilities). However, the readiness of the headmaster to accept modern teaching material also plays a part. Both reasons are relevant and lack of equipment in the school is often a consequence of the headmaster's reluctance to accept technical material.

Average lending of films to schools in the Göttingen area is approximately 23,000 for 1,300 schools, i.e. eighteen films loaned per class per year. In some schools, however, it is more than double. This means that the use of technical aids, which are considered significant by some schools, is as a rule only partial, and probably does not even represent 50 per cent of the full potential. On the other hand, loan of films per class is also only an average value. The differences within a certain subject at the same grade can be considerable from teacher to teacher.

If the number of media titles for individual subjects is related to the number of lessons given in one year in these subjects, taking into account that every film in one loan procedure is used twice (either for repetition in the same class or as a single presentation for parallel classes) it can be estimated that the schools in the Göttingen district make use of an approximate average of 40 per cent of the possibilities offered. Nevertheless, this percentage leads us to the conclusion that a substantial number of teachers use audio-visual material, not only as a decorative accessory, but also as a didactically determining element in teaching. A detailed examination of the present, the maximum and the optimal, i.e. of the desirable scope of the use of media in the individual subjects, has now begun in the centre.

An important document in this connexion will be a comprehensive and exact analysis of loan and use which will be drawn up after the end of 1975 with the help of electronic data processing equipment.

One important conclusion, however, can already be drawn from the aforementioned request figures. The period in which the District Media Centre in Göttingen had to strive to convince teachers of the possibility of applying media in teaching can be considered as over. What matters now is the maximum effective achievement on the basis of limited financial means through the most extreme rationalization.

Thus, for example, consideration might be given to the question of whether the delivery service should be maintained in its existing form.

When purchasing new media, the following action is usually taken: media titles which seem to be suitable for use in school, youth-welfare work, and adult education are first recorded in a quarterly catalogue supplement. The first and second request for the new title is fulfilled by renting the item. Only when three or more requests are received within a year, does the centre consider buying the item.

This procedure is designed to avoid an ineffective investment of capital to rarely requested media. Material given preferential treatment deals with human co-existence, the eradication of prejudice and the responsibility of the human being for his own actions, which would seem to compensate for the deficit in this area, compared with the progress made in the natural sciences and the technical sphere.

The second problem which greatly influences the effectiveness of available material results from the necessity of buying a second or third copy of a film. At present, the centre has reached a point where an extra copy can be bought for every five requests per half year, i.e. where six requests for a certain tape are received, there must be two copies of the tape in the archives.

On the basis of this procurement principle, up to fifteen copies of some films in the political and sexual education spheres have been made available. Five requests per half year constitute a more exact basis for calculation than ten requests per year since seasonal tendencies can be better defined by means of half-yearly statistics.

The third problem, relating to cost-effectiveness, this time with a negative effect, results from the question of availability of material. The two subsidiary branches of the District Media Centre in Göttingen are remnants of the period before the district reform of 1973. They are concessions to teachers' wishes to be able to collect a film outside the weekly delivery, without having to cover the relatively long distance between the outskirts of the district and the audio-visual centre.

The most important consideration at present on the theme of 'cost-effectiveness in resource-based learning' concerns access to the material. The centrally stored material is rarely available just when needed in the course of teaching. This situation can be alleviated by an increase in the number of film copies. However, the fact remains that the time needed to obtain the material is relatively long.

Through lack of availability of material, the technical aids, instead of facilitating operations, cause delays in the course of teaching and sometimes even cause unforeseen changes and thereby disrupt the teaching process. Such disruptions could be eliminated if every school had its own film archives.

This is by no means as utopian as it might at first sound. Certainly, if every school wanted to obtain a copy of every film available through the District Media Centre, then DM.1.5 million would have to be raised. But the larger part of the requests—a rough estimate would be about 60 per cent—refers to titles which altogether would necessitate a cost price of less than DM.200,000. An examination under way in the media centre in Göttingen is attempting to clarify how much money would have to be raised for the individual schools in order to reduce the orders placed in the course of a year at the Göttingen centre by 20 per cent. It must be borne in mind that by making material available to equip school audio-visual centres, the loan-centre staff in the media centre could, in the long run, be cut down; and without doubt, an increase in staff members, which would otherwise become necessary, can be avoided.

At the moment a loan transaction costs about DM.5. If a school with several parallel classes requests twice a year a series of slides at a cost, for example, of DM.30—parallel classes do not as a rule run simultaneously—then the cost of the work involved in the loan amount to DM.40 in four years. If these expenses divided over a period of four years are capitalized and interest paid at the rate of 8 per cent then it is cheaper for the district of Göttingen to give the series of slides to the schools rather than to lend them out again and again. The slide series, tapes and S-8 short films in the media centre—below a cost price of DM.100—are solely designed to enable the teacher to inspect and test the material. If he intends to use the material regularly, he should ensure that it is provided by the authorities for the school's collection of teaching aids. For this reason, the media centre generally has two copies of this material (value DM.100) at the most.

The building up of local collections could be advanced by means of permanent loans from the collections of the District Media Centre. The administrative work in local media centres can be assumed in large part by pupils under the guidance of a teacher or a school assistant. Pupils having a say in school affairs also means pupil co-operation. This has now stood the test for a long time in school administration and maintenance of teaching aids, which are school property, if the necessary advice, supervision and recognition is given for this work. Here is a hidden resource which has still not been correctly organized and used in many schools.

Basic principles for increased effectiveness of available material

The conversion of teaching from 'traditional' aims to 'new' aims has been going on for decades and will take a few more decades to complete. The conversion is only partly resource-based. It is not the new techniques, which determine 'the point and time of departure', but the new objectives, which demand a selection from resources either available or still to be developed.

The imput of the school can be measured in economic units. The establishment of units of measurement for the output of the school is difficult. Catalogues of teaching aims are at present *in statu nascendi.* Nevertheless, calculations of cost comparisons between various methods are possible. Here, the fixed and variable total costs of the school system should be considered and the cost-effectiveness relevance of all production factors be researched.

If two different types of material dealing with the same subject have approximately the same effect in teaching, then the material with the greater cost-effectiveness is the cheaper one. (It does not necessarily have to be sound films, sometimes a sound slide series will do as well.)

A small loss in effectiveness can be accepted if a considerable saving in cost is thereby achieved. (The last 10 per cent of the maximum efficiency technically possible is the most expensive.)

It is, however, uneconomical not to exploit a possible output increase of 10 per cent, if this increases the total operating costs of the school by no more than 10 per cent.

The fixed hardware costs of technical media in teaching are small in comparison with the cost of building a school. The ideal objective, according to W. Cappel: '...with the best equipment approximately 5 per cent: the usual figure throughout the state is at the moment 1.2 per cent'.

The running costs of media in teaching are, with the exception of computer-assisted instruction, mostly small in comparison with the running costs of the school system. The ideal objective, according to W. Cappel: '...under intensive use about 5 per cent (in the district of Göttingen it is about 1.4 per cent)'.

The economic law of diminishing returns in the isolated development of a single production factor is undoubtedly also valid for the use of technical resources in teaching. Relatively reliable examination of this problem, especially regarding the upper limit of meaningful use, has not yet been carried out.

Conclusions of the international experts meeting on information exchange on technical and economic studies related to educational technology

Unesco House, Paris, 14–16 January 1975

Résumé of discussions

Problems of cost were those most frequently discussed. However, the question of effectiveness, as well as its relationship with costs, was also discussed at some length.

Problems of cost

It was agreed that, in a preliminary phase and for practical reasons, an extensive knowledge of the cost of introduction of modern methods into educational systems must be acquired.

In order to acquire this knowledge, it is essential to: adopt a universal classification of costs; define methods of measurement; establish laws for variation of costs.

Classification of costs
After discussion, the commission agreed that a definition of universal categories is necessary if comparisons are to be made.

The classification proposed in the introductory report was thought to be on the whole satisfactory, but the following additions and modifications were proposed:

The categories retained must be broken down as far as possible to enable identification of operations and useful comparisons.

The technical classification should include a fifth category: implementation costs.

The economic classification should clearly distinguish two categories: fixed costs and variable costs.

Classification by contributors should include a fourth category: the international community.

In addition to direct costs encountered in the use of modern methods of training, there exist two additional categories which should be recognized in consequence of their importance:

(a) Opportunity costs: the difficulty of evaluating these was recognized, along with the necessity of separating them completely from expenditures.

(b) Psychological costs: these are very different from the preceding because to a certain extent they tend to constitute a limiting constraint on the effectiveness of modern methods rather than a source of budgetary expenditure. In certain cases, however, they could be covered by a financial incentive (for reconversion, for example).

Cost measurement

Three problems were brought up by the group:

Problem of reliability of cost measurements already carried out. Numerous speakers mentioned the danger of non-critical utilization of this data which has often been developed in a heterogeneous way, using incorrect methods. The frequent presence of three indirect ways of biasing, all tending to underestimate the cost of modern teaching methods was particularly underlined;

(a) The greater importance accorded to running expenditure than to capital expenditure when the latter is particularly high and the former somewhat lower in systems using modern educational methods.

(b) Use of official exchange rates when evaluating cost of imported materials.

(c) Personnel cost estimations based on present salaries without taking account of scarcity value related to new requirements in new systems.

Problems in defining unit cost. Certain members of the commission were of the opinion that cost per student was not always the most valuable definition. Use of the notion of cost per hour of teaching by modern methods leads to very different situations according to the unit applied, production time, transmission time, exposition time, etc. It was agreed that some sort of adaptation of the unit cost index to the problem studied should be developed.

Problem of discount rate. The rate chosen has considerable influence on the level of the cost evaluated. Specificity is therefore fundamental in the light of decision-making. The economist has no precise guidelines to help him make his choice.

Evolution of costs

Cost measurement is necessary if one is to arrive at an understanding of cost-effectiveness. Cost studies are made primarily to enable comparisons, in time and in space, and to sort out the laws of cost variation and discern which costs will prove the most advantageous. At this stage, three points were stressed by the meeting:

Comparison of results of cost studies already carried out rarely leads to establishment of laws because of the very high heterogeneity of situations observed and methods of measurement used.

The existence of significant economies of scale if 'big' media are used is postulated but in no way shown to exist. On the contrary, certain hypotheses on which these conclusions are based are manifestly false, particularly in respect of the vast possibilities of substitution between 'traditional' teachers and 'machines'.

An attempt must be made to measure the 'service capacity' of any given installation, i.e. the number of students above which the capacity of the system is saturated.

The existence of thresholds and disparities in the cost function process was evident to the meeting, but has not yet been sufficiently studied.

Problems of effectiveness

Effectiveness is much more difficult to measure than cost. Whilst recognizing this fact, the meeting estimated that:

Before allowing resources to be used for such studies, a careful examination of this problem is vital, as a knowledge of objectives and their relation to the media used should be acquired.

The several conceptions of effectiveness should be carefully differentiated:

(a) Educational effectiveness should not be confused with economic efficiency. The former should, in principle, be given priority, but everything depends upon the definition it is given.

(b) Educational effectiveness should be extensively defined. The essential point is not to find out whether one particular message, transmitted by one particular professor, has a smaller or greater effectiveness if 'teaching aids' are used but rather to compare different kinds of messages. The main problem is to discover whether new media are more efficient because they deliver new messages.

Efficiency measurement should take account not only of the working time of the professor, but also that of the student. All things being equal, the most efficient system is the one which permits the greatest economies in learning time.

There should, therefore, be a study in depth of the ways in which students 'learn' and what they gain from contact with a variety of media.

Nor is it enough to base results on previous studies which do not relate to the on-going situation, or to select a given medium arbitrarily. It would be useful to explore systematically the possibilities of using the theory of decision in uncertainty.

Relationship between cost and effectiveness

There was general agreement that these two subjects cannot be studied separately and further discussions brought to light the following two points:

1. In a preliminary phase, there should be an attempt at a systematic comparison of technical and economic costs and combinations of media which have a comparable effectiveness.
2. Studies of the cost-effectiveness relationship should take into account two control variables which have not so far been used: intensity of effort in preparing messages; intensity of student effort.

List of recommendations

The meeting, being of the opinion
that modern teaching methods *can* help solve *certain* educational problems;
that cost-effectiveness studies are *necessary* as an *aid* to decision;
that studies made up to now, although numerous, are not of much practical use for several reasons;
considers it desirable to make recommendations in the three fields of: information, cost measurement, the role of international organizations in improving the management of systems using modern methods of teaching.

Improvement of information

Recommendation No. 1. The meeting requests Unesco to study the problem of permanent exchange of information on the cost and effectiveness of modern teaching methods and to play an innovative role in the creation of a world-wide information network.

Recommendation No. 2. The meeting recommends a strengthening of co-operation between international organizations in this field and requests Unesco to take the necessary steps.

Recommendation No. 3. The meeting requests Unesco to disseminate a document including (a) an extensive list of existing studies, classified in such a way that the problems of cost-effectiveness are highlighted and (b) a sample of representative abstracts of the most important types of study.

Cost measurement

Bearing in mind that the priority which has been requested for cost studies is designed to ensure short-term effectiveness, the meeting makes the following proposals:

Recommendation No. 4. The meeting asks that a small working group meet to establish models of standard tables to present different types of cost, thus enabling a precise study of cost variations.

Recommendation No. 5. The meeting recognizes the willingness of Unesco to work on a grid specifying the hypotheses, framework, methodology of each study and would like to see the rapid establishment of such a grid.

Recommendation No. 6. The meeting strongly emphasizes the need to make effective use of the resources allocated for evaluation in all operational projects where evaluation has been foreseen.

Recommendation No. 7. The meeting recommends a development of case studies on actual projects in an attempt to discover solutions to specific problems raised by decision-makers.

Recommendation No. 8. The meeting requests Unesco to promote and encourage this type of study.

The role of international organizations in improving the management of educational systems using modern methods

Recommendation No. 9. The meeting hotes that international organizations, and especially Unesco, will participate, under terms of reference to be defined, in the establishment and development of training courses in methodology of cost studies.

Recommendation No. 10. The meeting would like Unesco to take the necessary action to facilitate management of educational systems using modern methods, for example by encouraging publication of a management guide.

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Constitution of the commissions

Commission I: Suggestions for publication of the annotated inventory of studies
Rapporteur: Mr Guillin.

Members: Messrs Dekens, Grabe, Guillin, Lefranc, Martin, Mazza, Nihan, Orivel.

Commission II: Economic problems
Rapporteur: Mr Eicher.
Members: Messrs Debeauvais, Eicher, Hallak, Jamison, Oatey, Schmidbauer, Singh, Mesdames Hommey, McDermott.

Commission III: Problems of the introduction of modern teaching media in the countries of the Third World
Rapporteur: Mr Konan Kouadio.
Members: Messrs Cabrera, Futagami, Konan Kouadio, Shah, Simon. Mrs Chong Lay Leng.

Ad hoc expert meeting: Standard tables for cost measurement

Unesco House, Paris, 18–19 June 1975

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Glossaries

Glossary of technical terms related to new methods [1]

Assessment
Measurement of a student's attainment.

Audio aid
Audio media used in teaching—supportive role only. *See:* Audio media.

Audio media
Equipment and related supplies—exclusive of audio-visual materials—by means of which information is presented through the sense of hearing. Such media include closed-circuit audio-equipment, dictating machines, radio, record players and tape recorders. *See:* Audio-visual media.

Audio-visual aid
A device, appealing to the sense of hearing and/or the sense of sight, that implements an educational process. Implies use of audio-visual equipment or materials in a supplementary or supportive role in teaching. *See:* Audio-visual media; Audio-visual material; Audio-visual equipment.

Audio-visual equipment
Mechanical apparatus capable of receiving, transmitting, or reproducing sounds and/or pictures; for example, film projectors, tape recorders, overhead projectors, closed-circuit television.

Audio-visual material
Films, tapes, transparencies, television programmes, etc., to be used with audio-visual equipment.

Audio-visual media
Audio-visual equipment, supplies and materials, by which learning is enhanced

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[1] Definitions without an asterisk (*) are from *Glossary on Educational Technology*, published in 1973 by the Internationales Zentralinstitut für das Jugend- und Bildungsfernsehen, Rundfunkplatz 1, D-8 Munich 2 (Federal Republic of Germany).

through the combined senses of hearing and sight, e.g. sound motion pictures, and television. Other audio-visual media include filmstrips or slides with sound, multi-media kits, pupil-response equipment and certain devices for programmed instruction. By usage, audio-visual media may also refer to equipment or materials that are either audio or video, appealing either to the sense of hearing or sight. *See:* Multi-media.

Cable television
Television service provided in whole or in part by a cable. A wired network or broadband communications network that has the potential of providing the services of audience polling, meter reading, instructional television, information services, and electronic mail as well as home programming services.

Carrel
A student study station, designed to facilitate effective independent study by students. It may include electronic or optical devices for display of information, teaching machines, and audio-visual transmission and reception facilities.

Cartridge
A container for film, tapes, slides or filmstrips. Some cartridges for film and tape contain endless loops; others operate on two spindles or by reel-to-reel transfer.

Cassette

1. An electromagnetic audiotape arranged in a cartridge format so as not to require tape-threading prior to recording or playback of programmes. Recording or playback is only possible with a cassette audio-recorder.
2. A film cassette: a small case for film that makes hand-loading of film unnecessary.

Channel

1. That section of the broadcast spectrum to which a television broadcast station is assigned or to which a video-camera capable of transmitting radio frequency signals is tuned.
2. In multi-tape recording, the conduit for simultaneous transmission of recorded messages from several programme sources to select student positions in the language-laboratory network.
3. A path along which information or communication can flow.

Closed circuit television (CCTV)
Usually a privately-owned, -maintained and -operated system whose transmission equipment is linked by co-axial cable, microwave relay or telephone lines. This type of television is often used as a video public-address system, but is also used in teacher observation, in teaching skills and in other skill techniques.

Communication satellite
An artificial satellite used to aid communications, as by reflecting or electronically relaying a radio signal.

Computer-assisted instruction (CAI)
The use of a computer to present instructional materials to a student. It allows for immediate feedback, self-pacing, branching and record-keeping.

Computer-managed instruction (CMI)
The use of a computer, not for instruction of the student, but for handling performance records, curriculum files, grading tests, etc. Also it may include the scheduling of non-computer media and teaching processes by automatic data processing.

Content analysis
A systematic attempt to establish the characteristics of a communication (e.g. a textbook or a television script): such an analysis could probe conceptual density, political bias, or whatever.

Control group
In an experiment, a control group is the group that is not subjected to the experimental factor or to the field test that other groups are subjected to. The results from this group are compared with the results obtained from the experimental or test group or groups.

* *Correspondence education*
Also distance education. System of teaching and learning based mainly on non-

personnel media whose efficiency for student performance is controlled by two-way communication. Media involved can include printed matter—programmed or not, mail, telephone, radio, television, sound and slides, sound- and video-cassettes, learning kits, computer networks, etc.

** Criterion-referenced testing*
A testing situation in which a student is evaluated on how well he achieves the established criterion or terminal behaviour.

Data processing
The preparation and handling of information by pre-determined procedures that classify, sort, etc. These procedures may be manual, mechanical or electronic (computer).

Dial access
A technical device which stores data so that they can be retrieved by dialling or otherwise signalling a code which will 'call up' any desired item or programme.

Educational radio
Radio used to offer educational programmes, including commercial programmes with educational content, to a private or public audience.

Educational technology

1. In its original sense, it means the media born of the communications revolution which can be used for instructional purposes alongside the teacher, textbook and blackboard, such as television, films, overhead projectors, computers and the other items of 'hardware' and 'software'.
2. The newer and more powerful definition of educational technology goes beyond any particular medium or device. In this sense, educational technology is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication and employing a combination of human and non-human resources to bring about more effective education.

Educational television
Television programmes specifically designed to achieve educational aims, either for reception in an educational institution or, in adult education, for reception in the home.

** Feedback classroom*
See: Student-response system.

Hardware
The physical components or equipment of a system: included are computers, terminals, audio-visual devices, programmed-learning devices, etc., used to distinguish machines from materials (software).

** Individualized instruction*
Learning procedure taking into account (in its objectives, content, methodology or rhythm) the particularities of the learner as opposed to autonomy (self-instruction) which signifies absence of the teacher either during the phases of the global learning procedure (total autonomy) or during one or only a few of these phases (partial autonomy).

Instructional media
Devices or materials that present a body of information and are largely self-supported rather than supplementary in the teaching-learning process.

Kit
A collection of instructional materials, giving information on a subject and assembled, perhaps in a folder for distribution. *See:* Package.

Live programme
In real-time: that is, the message originates simultaneously or nearly simultaneously with its display and perception.

Media centre
A learning centre with print and audio-visual media, essential equipment and

services from media specialists and accessible to teachers and students.

Mobile television unit
A truck or trailer equipped with television units to permit the recording of programmes in the field. Some units are equipped with microwave facilities to communicate with the home-base station.

Monitor
A receiver tube and associated circuits used for mixing signals and video-only presentation of performances for final viewing. Usually referred to in connexion with various smaller receiving sets used in cueing or for master control of output.

Multi-channel programming

1. An increase in the number of television channels, in the diversity of programmes offered, and in the types of organizations sponsoring them.
2. A multiple-programme system for a language laboratory.

* *Multi-media*
A planned combination of media into a system in which the role of each medium is distributed according to its potential, thereby reinforcing the value of each medium taken separately (as opposed to the non-planned additive use of several media).

Multiple-choice question
Kind of question common in objective tests and branching programmes. Along with the question appear several alternative answers, usually one correct and the others plausible but incorrect. The student is requested to choose the correct answer.

Network
A series of reception, display or redistribution points that are interconnected so that they may simultaneously share the same programme.

Open University (trade mark)
A British higher education institution providing degree-level tuition to adult students working at home by means of an integrated multi-media learning system comprising programmed correspondence material, textbooks, regular television and radio broadcasts, marked assignments, residential summer schools and local tutorial groups.

* *Open-circuit television*
Regular home broadcast transmission of very high frequency (VHF) and ultra high frequency (UHF) television channels used for the transmission of programmes to non-captive audiences (as opposed to closed circuit television).

Optical reader
In data processing, the electronic process of reading and recognizing written symbols by reflecting light from the written page through an optical system to a light-sensitive device. This device converts the reflected energy into electrical impulses which may be transmitted as a digital representation of the information on the written page.

Package
Normally refers to a multi-media collection of materials for individual or group learning of a certain topic, together with instructions as to how they may be used. *See:* Kit.

* *Programmed instruction*
Programmed instruction is a method of learning constructed as an instructional system or sub-system, characterized by its utilization of prestructured learning material made up into a validated programme. It is a self-sufficient instrument for learning based on specific learning objectives and is designed for a target population with specific traits.

Programmed material
Books, slides, films, television and radio programmes, sound tapes and discs and any other materials used to present programmed learning.

* *Radiovision*
An instructional media system presenting static visual media and sound. The sound

portion is transmitted by radio, while visual materials are projected (or displayed) at the point of reception.

Self-instructional
Describing methods, materials and devices that make it possible for a student to learn without direct help from a teacher. Generally, the term is used in a programmed learning context, but materials such as textbooks, films, radio and television programmes and sound recordings can be considered as self-instructional if the student is expected to learn from them directly.

Simulator
A device constructed to give safe and effective practice in handling the essential features and real equipment in a way that would be impossible with the equipment itself.

Software

1. All types of programmes and procedures required for directing the operation of a computing system. Software is written in a formal language that can be processed by the computer.
2. Transmitted programmes and/or messages as well as recorded programme materials, e.g. film, tapes, books, discs, etc., containing recorded messages.
3. Working materials from which a programme for radio, film or television is created. May include scripts, written narration, audio- and visual-aids, etc., especially created or assembled for the production.

Sound page
An instructional media system involving separate pages of hardcopy with sound recorded on the back of each page. The page is placed on the top of a record/reproduce machine: the learner views the page and hears the sound.

Sound-track
A narrow band running along one side of the film and carrying the recorded sound. Optical sound-track is a photographic image that activates a photo-electric cell; magnetic sound-track is a coating of ferrous oxide in contact with a magnetic playback head.

* *Student-response system*
(or feedback classroom). A type of teaching machine consisting of individual multiple-choice response units linked by cable to a control console. It provides mainly facilities for objective testing at low cost. Feedback to the class teacher is instantaneous with the simultaneous display of the assessment of response to both teacher and student.

Teaching machine
A mechanical or electronic device for presenting the frames of a programme either on paper or on film. The student may be able to write his response on to the programme through a window in the machine or he may need to press buttons to record his responses. If such a machine is linked to a computer it can control the rate at which the programme is presented.

Team teaching
A means of breaking away from the narrowness of having one class taught by one teacher only, team teaching allows several teachers, as a group, to work with several classes together. A simple team-teaching situation would be for the teacher with most knowledge of, or interest in, a certain topic to present it to all the classes together and then join with his colleagues in pursuing a variety of pre-planned follow-up work with individual students or small groups.

* *Telecommunication*
The transmission of data over radio circuits or transmission lines by means of electromagnetic signals.

Telephone instruction
Instruction in which a telephone provides two-way communication between a class and a resource person, or between a home-bound pupil and his regular classroom.

Terminal
A device by which data can leave or enter a computer system; as used in computer-managed instruction, a cathode-ray tube

display (similar to a television screen) with alpha-numeric typewriter keyboard.

* *Video*
Referring to television as opposed to film.

Video cassette recording
(VCR)
A videotape recording in a self-threading cartridge or cassette and suitable for playing through a home television set or other television receiver.

* *Videotape recording*
(VTR)
A recording system which stores video and audio information by transferring electrical signals directly on a magnetic tape.

Glossary of main economic terms

Amortization
Accounting procedure for the replacement of unserviceable items of fixed capital by reserving amounts equal to the estimated value of that capital. The task of measuring amortization gives rise to two problems:

1. Accounting amortization differs basically from economic amortization in that the amounts reserved correspond not to the actual depreciation of the capital but to the maximum amount authorized by the fiscal authorities. For the purposes of cost-effectiveness studies, it is preferable to measure economic amortization. Where this is not possible, it should be made clear that the evaluation is based on fiscal amortization.
2. The replacement of technical items of fixed capital by identical items is not normally possible because of modifications made to equipment.

Calculations must therefore be based on the value of the new equipment, measured, if possible, in constant monetary units (which must be defined).

Cost
Sacrifice or disbursement incurred in order to create capital or to enable an organization to function. The notion of cost has many aspects. Several classifications by type of cost are therefore possible, the three most important being: economic cost, financial costs and technical costs.

Economic cost
Sacrifice measured in terms of scarce resources used. Economic cost is not the same as expenditure since some costs entail no expenditure (e.g. loss of receipts resulting from an activity) and some forms of expenditure do not constitute a cost (e.g. expenditure covered by transfer earnings). This general notion of cost can also be called opportunity cost. The categories of economic costs most frequently employed are the following:

Sunk cost: Cost incurred once for all, before any production takes place and independent of fluctuation in production (e.g. the purchase cost of buildings or teaching machines).

Constant cost: Cost associated with the productive activity but independent of the level of production (e.g. the cost of the insurance or of caretaking services). It can also be called invariable cost.

Variable cost: Cost linked both to the productive activity and to the level of production (e.g. the cost of school books).

Average cost: Total cost divided by the number of reference units. This is also known as unit cost. In education, the reference units most frequently used are number of pupils and number of teaching hours.

Marginal cost: Variation in total cost when the number of reference units is increased by one (e.g. marginal cost of one pupil).

Expansion cost: Cost involved in increasing the size of a system. Expansion cost is a marginal cost but may be irregular when additional expansion calls for additional investment (e.g. laying a new cable for picture transmission or building a new transmitter).

Present value: Cost measured in current monetary units (e.g. if a certain item of expenditure costs 1,000 1974 Francs in 1974, and if prices have increased by 10 per cent between 1974 and 1975, the 1975 present value is 1,100 1975 Francs).

Replacement cost: Cost involved in replacing unserviceable equipment. If replacement by an identical item is not possible (*see: Amortization*), the replacement cost is that of equipment which will provide approximately the same service as the former equipment.

Accounting cost: Expenditure undertaken for the purpose of acquiring capital or for paying staff or for current consumption requirements. A distinction is made between two categories of accounting costs: (a) *initial or investment cost*—expenditure undertaken for the purpose of capital formation; this concept is similar to the economic concept of fixed cost, differing only in that economic cost is not equal to expenditure; (b) *recurrent or operating cost*—expenditure undertaken for the regular operation of an organization or institution and carried over from one fiscal period to the next; this concept approximates to the sum of constant and variable costs as defined in economics.

Financial cost

Cost broken down according to contributors. The subdivisions used for this purpose are normally as follows: the educational establishment; the community; the outside world (e.g. external aid); the users.

Technical cost

Cost related to an identifiable activity involving recourse to a specific form of technology. Technical costs are usually classified into four major categories corresponding to the four major types of technical operations successively required for the reception of an educational message by the student or students for whom it is intended.

Conception cost: Cost associated with the development of the educational message (e.g. selection of a modern language text and of questions to accompany it).

Production cost: Cost of incorporating the educational message into a technological medium (e.g. the cost of recording one hour of educational message on a cassette). Certain studies make a distinction between production cost and a subsidiary category—pre-production cost. This is the cost of incorporating the educational message in a technical medium on an experimental basis, as an aid to its development in final form. Admittedly, this operation is technically related to production but, logically, it forms part of conception.

Distribution cost: Sum of the costs associated with transmission of the educational message and bringing it within the reach of individual users. Operations entailing a distribution cost differ greatly according to the type of medium used: first, if the message is disseminated by means of radio and/or television broadcasts, the distribution cost is the same as the transmission cost (e.g. the cost of one hour's broadcasting of a television programme for schools); second, if the message is disseminated by means of individualized media (cassettes, books, films, etc.), the transmission cost is made up of two elements: the cost of duplicating the message (e.g. copies of the film) and the cost of circulating the copies (e.g. cost of sending the film).

Utilization cost: Sum of the costs of bringing the message to the actual students. This cost may be directly related to the technical medium required for disseminating the message (e.g. the cost of projecting a film); it may also arise from the need to provide premises for the students (e.g. construction of an auditorium) or from conditions to be met so that the message can be received and understood (e.g. operator's salary or salary of the teacher who gives a commentary on the message).

Discount
Operation consisting of reducing the apparent value of a future receipt or payment by a certain percentage in order to take account of foreseeable depreciation.

Discount rate: Rate of depreciation applied to a future flow.

Efficiency
Ability to produce an effect. As far as educational methods are concerned, the desired effect is the transmission and assimilation of an educational 'message'. We are concerned essentially, therefore, with educational efficiency.

Economic effectiveness (or efficiency): The extra product (at community level) or revenue (at individual level) derived from the employment of scarce resources for education. If the educational efficiency is the same, there should be no difference in economic efficiency between instruction using modern methods and traditional instruction. The cost-effectiveness ratio, on the other hand, may obviously differ in so far as there is a difference in cost between the two methods.

The expression 'cost-benefit' is also used to express the same economic ratio.

A distinction is made between 'efficiency' and 'advantage', the concept of advantage being broader than that of efficiency. It includes non-measurable benefits, mainly of the psychological type (e.g. the pleasure that may be experienced from being in contact with a likeable teacher rather than a tape-recorder), whereas the concept of efficiency covers only measurable advantages.

Effectiveness: Synonym of efficiency.

As educational institutions increasingly use new educational media including radio, television, programmed instruction and audio-visual centres the need for evaluating the costs and results has grown. This volume provides standard tables which can be applied, as well as examples of significant case studies.

Prepared with the assistance of the International Council for Educational Media (ICEM), it describes the current state of cost analysis along with grids indicating the hypotheses, framework and methodology adopted for case studies. Further examinations of these problems will be issued by Unesco if developments in cost-effectiveness studies warrant.

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